Railway Age Gazette
MECHANICAL EDITION
INCLUDING THE
AMERICAN ENGINEER

PUBLISHED ON THE FIRST THURSDAY OF EVERY MONTH BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY,
WOOLWORTH BUILDING, NEW YORK, N. Y.

CHICAGO: Transportation Bldg. CLEVELAND: Citizens' Bldg.
LONDON: Queen Anne's Chambers, Westminster.

EDWARD A. SIMMONS, *President* L. B. SHERMAN, *Vice-President*
HENRY LEE, *Secretary*
The address of the company is the address of the officers.

ROY V. WRIGHT, *Editor*
R. E. THAYER, *Associate Editor* A. C. LOUDON, *Associate Editor*
C. B. PECK, *Associate Editor*

Subscriptions, including the eight daily editions of the *Railway Age Gazette* published in June in connection with the annual conventions of the Master Car Builders' and American Railway Master Mechanics' Associations, payable in advance and postage free:

United States, Canada and Mexico	$2.00 a year
Foreign Countries (excepting daily editions)	3.00 a year
Single Copy	20 cents

Entered at the Post Office at New York, N. Y., as mail matter of the second class.

WE GUARANTEE, that of this issue 5,000 copies were printed; that of these 5,000 copies 4,333 were mailed to regular paid subscribers, 200 were provided for counter and news companies' sales, 209 were mailed to advertisers, exchanges and correspondents, and 258 were provided for samples and office use; that the total copies printed this year to date were 14,300, an average of 4,767 copies a month.

The RAILWAY AGE GAZETTE, MECHANICAL EDITION and all other Simmons-Boardman publications are members of the Audit Bureau of Circulations.

VOLUME 89 MARCH, 1915 NUMBER 3

CONTENTS

EDITORIALS:
Help Keep the Premises Clean 105
Alterations in Locomotives to Increase Capacity 105
Design of Reciprocating and Revolving Parts 106
Billing Repairs on Foreign Cars 106
High Power per Unit of Weight 106
Economical Maintenance of Equipment 107
The Value of the Locomotive 107
New Books 107
COMMUNICATIONS:
Practice Versus Theory in Design 108
The Bonus System 108
GENERAL:
Reciprocating and Revolving Parts 109
Uncoupling Lever for Switch Engines 115
Portuguese Express Locomotive 116
Economic Value of a Locomotive 118
CAR DEPARTMENT:
The Standard Box Car—A Negative Viewpoint 121
Piece Work and Its Advantages 122
Steel Baggage and Mail Cars 123
Experiments to Determine the Stresses in Truck Side Frames 127
Economies in Freight Car Repairs 129
SHOP PRACTICE:
Clips for Securing Date Tags to Steam Gages and Safety Valves 131
Points for Apprentices to Ponder 132
Chuck for Finishing Boiler Check Bodies 133
Shop Notes from the Soo Line 133
Engine House Organization 135
Water Gage Cocks 136
Shop Efficiency 137
Packing Iron for Journal Boxes 137
Special Beading Tool and Boiler Patch Bolt 137
Reboring Air Pump Cylinders 138
Machine for Boring Driving Boxes 138
The Best Practices in Engine House Work 139
Some Factors in Locomotive Maintenance 140
Index Head for Holding Rod Brasses 140
NEW DEVICES:
Roller Journal Bearing 141
Hydraulic Pipe Bender 142
Vertical Band Saw for Metal Cutting 142
Automatic Nut Tapping Machine 143
Car Wheel Grinder 143
Forged Brake Beam Fulcrum 144
Adjustable Fire Door Pedal 144
Pneumatic Plate Flanging Clamp 145
Safety Hose Clamp 145
Triplex Hydraulic Pump 146
Sand Blast Helmet 146
Heavy Duty Universal Milling Machine 146
Pneumatic Light Forging Hammer 147
Magnet for Removing Metal from the Flesh 148
NEWS DEPARTMENT:
Notes 149
Meetings and Conventions 150
Personals 150
Supply Trade Notes 152
Catalogs 154

Help Keep the Premises Clean

"With a pig and a goat your plant would compare favorably with some back yards I've heard about," is a remark made by a superintendent to the man in charge of one of the company's shops. He might have said much more as to the advantages to be derived from neat shops and premises, but he believed that the comparison was enough, and in this case it proved so. There are other railway shops in this country to which this same remark might apply. To them we desire to convey the message that neat, clean shops will do much to increase output, inspire careful workmanship, keep the employees contented and advertise the road in the right way. At the Burnside shops of the Illinois Central the officers make it a special point to keep the shops and surroundings orderly and as neat as the conditions will allow. Barrels made of scrapped corrugated roofing are placed at various points throughout the plant; they are painted white and kept that way. An inscription "Help Keep the Premises Clean" is neatly lettered on the covers. These white barrels contrast so vividly with the black cinder grounds that it is impossible to forget the purpose for which they are intended. The entire plant maintains a Sunday appearance day in and day out. The men like it and the shop officers believe that they are fully repaid for their trouble. It costs but little to do this and the advantages are many; you will be better satisfied with your work and the work of your men will better satisfy you if this policy is followed.

Alterations in Locomotives to Increase Capacity

The Kansas City Southern has recently completed some tests which were conducted with a view to modernizing a class of consolidation type locomotives. As originally built these engines had a tractive effort of 44,900 lb. and a weight on drivers of 182,600 lb., 22 in. by 30 in. cylinders, 55 in. driving wheels, a boiler pressure of 200 lb. and a grate area of 33.5 sq. ft. Alterations were made to two of them, one being fitted with a wide firebox providing a grate area of 62.5 sq. ft., while the other was fitted with a superheater, a brick arch and a design of piston valve chest which is applied directly to the slide valve seat and avoids the necessity of applying new cylinders. The cost to convert the engine which was equipped with a wide firebox, was $4,850, while the cost for the other engine was $2,775, the difference being about 43 per cent in favor of the latter locomotive. In comparative fuel tests the locomotive with the narrow firebox and a superheater used 24 per cent less coal per 100 ton-miles, 33 per cent less water per 100 ton-miles and developed an average running speed 15 per cent higher than the locomotive with the wide firebox. On a tonnage test the percentages in favor of the superheater locomotive were, in ton-miles, 15 per cent increase, running speed 11 per cent increase, fuel consumption 16 per cent decrease and water consumption 29 per cent decrease.

These figures are of more than ordinary interest as showing what can be done, by the expenditure of a comparatively small amount of money, in the way of increasing the capacity of many locomotives that have been or are now being pushed aside. In this case the factor of adhesion was such that an increase in the size of the cylinders would hardly be justified and it is doubtful whether the strength of the frames would permit such an increase. But there are plenty of other cases where different expedients should be justified in order to obtain another five or ten years' service on tonnage trains from existing locomotives. There have been quite a number of locomotives built within recent years with factors of adhesion lower than what was formerly considered good practice, and if the locomotive which it is desired to convert has a factor of 4.5 or over it is quite probable that an increase in the size of the cylinders could be safely made, provided the frames were strong enough to stand this increase. However, an increase of 2,000 or 3,000 lb. in maximum

tractive effort might well justify the replacing of the frames as well as the cylinders and as it is unlikely that such a conversion would be considered without the application of a superheater there would be, beside the increase in maximum tractive effort, a decrease in fuel and water consumption and a decided increase in sustained capacity. Moreover, the additional weight resulting from the superheater and allied changes would help in preventing the factor of adhesion from reaching a point which might be considered too low.

Any conversion of this nature will, of course, have to be justified by the results afterward obtainable and the changes just outlined would unquestionably run into a considerable amount of money. But there must be many cases where such modernizing methods would be justified provided the money for making the changes can be obtained. Under present day railroad conditions the question, "What will it cost?" comes with increasing emphasis and if the results obtained in the case of the Kansas City Southern locomotives are considered in relation to the cost of making the conversion, they will undoubtedly make a strong appeal to higher railway officers.

Design of Reciprocating and Revolving Parts

At all times a serious problem, the design of reciprocating and revolving parts for steam locomotives has greatly increased in difficulty with the advent of the high piston loads which result from the use of cylinders of the large diameters now common in locomotive practice. The real seriousness of this problem is probably best brought home by consideration of the effect of the pressure on the rail. When, with the high axle loads now in use, a variation between the maximum and the minimum weight on the rail, under any driving wheel, of 100 per cent of the static weight on that wheel may, and probably often does, result from the effect of the counterbalance, it can be readily seen that stringent measures are justifiable in reducing the weight of the parts of the locomotive which necessitate this counterbalance. In the article on "Reciprocating and Revolving Parts," which is published in another part of this issue, it is stated that the practical problem of balancing is not so much how to balance as how to reduce the total weight of the reciprocating parts to a minimum. There are a number of locomotives now in service, built during the past two or three years, which stand out very clearly as regards the design of these parts when compared with the average practice, and there seems no reason why such good results could not be more generally obtained. Indeed, it is plainly indicated by Mr. Campbell in this series of articles that they can be. The series is divided into three parts, Part 1 dealing with American design, Part 2 with British design and Part 3 with the use of alloy and heat treated steels. The author is already known to many of our readers and will be remembered as the writer of the article on "Locomotive Connecting Rods" published on page 175 of the *American Engineer* for April, 1913. This article was most favorably received, and is being very generally used by designers, and it is hoped that the present series will prove even more valuable as an aid to improved locomotive design.

Billing Repairs on Foreign Cars

Rather strong insinuations have sometimes been made concerning the honesty of some roads in regard to their bills for foreign car repairs. The paper read by H. H. Harvey, general car foreman of the Chicago, Burlington & Quincy, at the February meeting of the Car Foremen's Association of Chicago, in which he advocated the appointment of inspectors by the M. C. B. Association for inspecting foreign car repairs, we believe states the case correctly. Mr. Harvey said:

Without question, all roads do at times make improper charges, but in most cases, these are simply errors and not made with deliberate intent to defraud. However, it is quite possible that some few car owners deliberately charge for repairs not made, possibly not with the consent of the higher officers, but through the zealousness of some of the minor officers, who are endeavoring to make a record for low cost of maintenance. These few, if there be such, are the ones who are to blame for the charge of dishonesty in repair bills, under the stigma of which all must suffer, the innocent as well as the guilty.

We believe that errors are the greatest causes for the improper charges and, further, that the errors are caused by the lack of a proper knowledge of the M. C. B. rules. Last month it was pointed out in these columns that ignorance of the rules was the cause of a large amount of unnecessary correspondence. It would seem, therefore, that much of the trouble now common in the handling of repairs to foreign cars could be eliminated if the men were made to learn the M. C. B. rules thoroughly and to use them intelligently. Some roads appoint inspectors whose duty it is to visit the various repair points of the road and check up the work done in repairing cars with the bills made out for these repairs. In the discussion of Mr. Harvey's paper it was stated that this procedure had resulted in satisfactory results and many cases were found where the foremen were cheating themselves. These inspectors, reporting direct to the superintendent of motive power, bring to light the weak spots in the car department, whether they be caused by ignorance of the rules or by over-zealous foremen endeavoring to make a showing. If this practice were generally adopted it is probable that the complaints for incorrect charges would be reduced materially and both the home road and foreign roads would be materially benefited.

High Power Per Unit of Weight

The development of over 2,000 indicated horsepower by a balanced compound passenger locomotive having a total weight of 165,300 lb. is a performance rarely, if ever, equalled in American practice. Such results are reported to have been realized in service from a recently built ten-wheel express passenger locomotive on the Portuguese State Railways, a description of which appears elsewhere in this issue. The conditions under which this power was developed are not known, and it is impossible to say whether it represents sustained performance or the power developed during a short period only. Two balanced compound Atlantic type locomotives, the cylinders of which compare very closely in size with those of the Portuguese locomotive, were tested on the St. Louis testing plant, the maximum indicated horsepower of each being between 1,600 and 1,700. The boilers of both of these engines were larger than that of the Portuguese locomotive, one having a total heating surface of 3,407 sq. ft. and the other a total heating surface of 3,237 sq. ft.

Atchison, Topeka & Santa Fe engine No. 535, with a total weight of 201,500 lb., a total heating surface of 3,237 sq. ft. and a grate area of 48.4 sq. ft., was shown by the test to be capable of maintaining a maximum indicated horsepower of 1,605 at 54 per cent cut-off with a steam consumption of 20.8 lb. per indicated horsepower hour. The Cole balanced compound, New York Central No. 3,000, with cylinders 15½ in. and 26 in. in diameter by 26 in. stroke, weighing 200,000 lb. and having a heating surface of 3,407 sq. ft. with a grate area of 49.9 sq. ft., was shown by the tests to be capable of developing a horsepower of 1,670 at 52½ per cent cut-off with a steam consumption of 23.2 lb. per horsepower hour. Comparing the Portuguese locomotive with these engines the possibilities for such a performance on its part are not evident. If this engine is capable of developing over 2,000 indicated horsepower, it must have an unusually low water rate for a saturated steam engine as, assuming a maximum evaporation of between 37,000 lb. and 38,000 lb., which would be higher than is usually obtained in American practice from the same heating surface and grate area, the maximum horsepower of the Portuguese engine must have been obtained at a water rate of about 17 lb. per indicated horsepower hour.

Economical Maintenance of Equipment

C. A. Seley stated at the January meeting of the Western Railway Club that the biggest question before the railroads at the present time is the proper and economical maintenance of equipment. This question, at all times a live issue with the mechanical department of American railways, is especially so at present. Each new design of equipment, with new machines for doing the repair work and with fluctuations in prices of material, alters the maintenance problem in some respect, and this problem is one that is worthy of study by the ablest men in the field.

Maintenance should first be considered when designing the equipment, and whenever possible, parts that are liable to need repairs or replacement should be so located and incorporated in the structure that they may easily be repaired or renewed. This necessitates the designers' familiarizing themselves with the repairmen's problems. From these men a great many details can be learned which, if carefully considered in designing, will show marked economies in the cost of repairs. The repairmen, on their part, should, from their experience, anticipate the making of repairs with special devices or jigs where the number of cases warrants such devices, in order that the work may be done as quickly as possible and with a minimum labor cost. They will also do well to study the supply field for machines and apparatus, the purchase of which may be of material assistance to them in their work and which with the saving in the cost of repairs will be a profitable investment for their companies.

An economical feature in which all railway mechanical men are directly interested is the reclaiming of scrap material. Several railroads are giving this subject attention; some have installed extensive plants for this specific purpose, while others are giving it a very close study with a view of enlarging the plants they now have in operation. There are numerous other avenues for maintenance economies. Every man should put his shoulder to the wheel. Give the companies the best ideas you have.

The Value of the Locomotive

If the ideas in G. S. Goodwin's paper on the "Value of a Locomotive," presented at the February meeting of the Western Railway Club, and abstracted elsewhere in this issue, are thoroughly studied, followed and elaborated on by the railway mechanical men of this country, we will find mechanical departments operating on a scientific basis that heretofore has not been thought possible. Mr. Goodwin established a basis—the net earning power of a locomotive—from which should be determined the method of handling power. He has shown that the average net earning power of all locomotives in this country is $44 a day. He has also shown that for individual engines this value will vary greatly according to the conditions under which they operate. It will be found that locomotives of low net earning capacity will require a different method of handling from those of high net earning capacity if true economy is to result.

Some motive power men strongly advocate the regular assignment of engines; others are advocates of pooling the service. The former claim more mileage, fewer failures, more reliable service, etc., while the latter's chief argument is that fewer engines are required and that there is always an engine ready for the transportation department. But we only hear the mechanical man's point of view, and he has only based his arguments on the results he sees, not on an analytical economic study. We have yet to hear from a purely economic point of view as to which is the better system. A scientific economic study of this question would be of great advantage to all the railways and would undoubtedly lead to many changes in the methods of handling motive power. Mr. Goodwin has outlined a basis on which to work.

Strong exceptions were taken to 53.96 per cent of a freight locomotive's day being charged to the mechanical department, especially as the road from which these figures were obtained operates under the pooling system. Under the circumstances it is almost impossible to question the figures, as the system by which they were obtained had been in effect for some time. With this statement the question naturally arises, "What must be an engine's dead time in the regular crewed system?"

NEW BOOKS

Installing Efficiency Methods. By C. E. Knoeppel. 258 pages, 6¾ in. by 10 in. Illustrated. Bound in cloth. Published by the Engineering Magazine, 140 Nassau street, New York. Price $3.

There have been so many books published within recent years dealing with the principles of scientific management that when a new one is brought out it arouses but little interest. In this book, however, Mr. Knoeppel endeavors to avoid the matter of a mere declaration of principles and tells what the methods are that are known to increase the efficiency of a manufacturing plant and also how they are put into use. The introduction to the book states that the purpose has been to give wholly frank and thoroughly practical working instructions and explanations, covering the entirety of efficiency practice as tested and proved in many important and successful undertakings carried out by the author; it would seem that this purpose has been effectively carried out. As originally prepared, the material in the book appeared in a series of articles published in the Engineering Magazine during 1914, but this is expanded and changed to a considerable extent in this volume. The chapter on the efficiency clearing house has been considerably enlarged and chapters added on costs and on auxiliary devices for the planning department. A considerable number of charts, diagrams and illustrations have also been added.

Heat-Treatment of Steel. Compiled by the Editors of Machinery. 278 pages, 6 in. by 9 in. Illustrated. Bound in cloth. Published by the Industrial Press, 140 Lafayette street, New York. Price $2.50.

During the past two decades developments have taken place in the processes involved in the building of machinery as well as in the materials of construction, which have produced many changes in the heat-treatment of steel. The introduction of high speed steel for cutting tools and the various alloy steels, the usefulness of which depends almost entirely upon proper heat-treatment, has made necessary the careful study of processes and has produced many remarkable changes in practice. In the preparation of this book it has been the purpose to place on record the modern methods of heat-treatment, and although largely descriptive in its dealing with the subject, the book will be found to contain much practical data of value to those who have to do with heat-treating operations.

The first chapter is devoted to a theoretical discussion of the effect of heat-treatment and a brief digest of the results to be obtained by various methods of treating carbon and alloy steels. In the following chapters the various processes of hardening, quenching, tempering, annealing and casehardening are described in detail, the text being amplified by numerous engravings showing the construction and methods of operation of the furnaces and other appliances. The application of the electric furnace to heat-treating operations is dealt with at considerable length and a chapter is included on the newly developed method of case-hardening by carbonaceous gas.

A brief treatise is included on the methods used to measure the hardness of metals. Various types of hardness testing machines, developed in this country and abroad, are described and the principles on which they operate set forth.

The information contained in the book has been mainly compiled from articles published in Machinery and from the well known Machinery Reference Books, and it forms a very comprehensive treatise on a subject about which little of a practical nature has been written.

COMMUNICATIONS

PRACTICE VERSUS THEORY IN DESIGN

New York, N. Y.

To the Editor:

On page 451 of your September, 1914, issue you print an interesting editorial entitled "A Word of Thanks." You therein invite a "frank and square-from-the-shoulder criticism" of things you publish. I wish to accept your invitation and 'hand you one" on the subject of co-operation. In your "Word of Thanks" you say your whole heart and soul is set on bettering things in your particular field, etc., and in the final paragraph you state the truism: "After all, we are really one big association with one common interest, and each one of us owes it to all the others to do our little part in making the mechanical department more effective and more efficient." With the next stroke of your editorial pen, however, you excite discord where harmony and co-operation are of the utmost importance to the "common interest" for which you had just appealed. I refer to your editorial, "Limitations of The Designer." Damage is done by your editorial because you cite a specific case and from it draw a general conclusion, and in doing so you furnish fuel for the fire of antagonism between the "practical" and the "theoretical," which is such a serious detriment to progress in any industry.

The designer in a railroad organization is never an independent unit with authority to depart from standards and arrange apparatus to suit himself. The designer is, however, a member of the big association, specially trained in the theory of mechanics and in the work of reducing to a tangible and practical form on the drafting table the various features and arrangement of parts desired in a device or machine. The perfection of the result will depend largely on the thorough study given to the details of the design *in order that it may incorporate all the good features which the operation and maintenance of such machines have shown to be advisable.* Here is where the co-operation of the practical and theoretical is of the utmost importance, and the head of the department or the one responsible for the finished result of the designer's work should see to it that the designer not only co-operates, as in this case, with the man who has "spent his life running locomotives," but also with the man who spends his life in maintaining locomotives. For example, see "Air Brake Repairs," page 165, Railway Age Gazette, July 24, 1914.

Great progress has already been made by the patient and constructive analysis of existing designs of apparatus through the co-operation of the manufacturer, operating men and designing engineers in an effort to perfect the design for the good of the common interests. This good work will go on and further improvements will be made when the hearty co-operation of every individual of our "one big association" is enlisted in the desire for the success of the new design, be it of a car, locomotive, shop or other equipment for the road. In the editorial you give credit to the mechanical engineer for the design of a particularly good box car, because of co-operation with the operating men. Why, then, blame the designer when the same co-operation was not insisted upon in the engine design?

Co-operation cannot be secured by a jerk, but by the steady pulling together of all the many members of the "big association" of the railway industry. The united efforts of so many experienced and trained minds will eventually result in remarkable improvements in working conditions and in operating costs.

We all have our limitations, even editors, as witness the appeal for help in your "Word of Thanks." If the editor of a great journal needs help through co-operation with the "practical," how much more must the designer need such help? In conclusion, I refer to the final sentence of your editorial, "A Word of Thanks," and hope that this communication may "help the editor" to co-operate with the designer in enlisting the aid of the "practical" in the perfecting of the work intrusted to him.

F. M. Brinckerhoff.

THE BONUS SYSTEM

Toledo, Ohio.

To the Editor:

While I have read many criticisms of the bonus system for the payment of labor, I believe that such a system can be established in any manufacturing plant by a capable efficiency engineer. This has been proved by the results of such installations in many cases.

The reasons for the failure of the bonus system in so many instances are not the faults of the system itself but may be traced to the short-comings of the so-called expert who is responsible for the many radical changes both in organization and shop practice which usually accompany the installation of a bonus system. The expert is very frequently deficient in a number of ways. He often has to learn the business of his client at the client's expense; he possesses too much egotism; his work is frequently too largely based on theory unbacked by practical experience. He is seldom well enough acquainted with the design of machinery, tools, jigs and fixtures. Through lack of tact he antagonizes the workmen, who in turn can very easily make impossible the determination of a basis for a fair standard. His standards are often the result of rough estimates which may do injustice either to the workmen or to the management.

To be worthy of the title of efficiency engineer one should be an engineer capable of directing the design of labor-saving devices such as special tools, jigs and fixtures. He should be able to locate machine tools for the most economical production. He should thoroughly understand the bonus system; but it is not worth while to make time studies for the purpose of establishing standards of performance for the workmen until the location of the machinery has been thoroughly investigated and until the best possible use of jigs, templates and other special tools has been made. He should be able to set up work in a machine and operate it himself, such an accomplishment being invaluable in securing the confidence and respect of the workmen. He should have the good judgment necessary to establish standards of performance which will prove satisfactory, both to the workmen and to the management. I have known so-called experts, in arriving at standards for automatic machines, to speed them up to their maximum production, thereby setting a standard so high that the workmen were never able to earn a bonus.

W. H. Wolfgang.

Temperature Indicating Paint.—A paint which changes color at various temperatures has recently been brought out in Europe, says F. J. Rankin of the Colorado Agricultural College. When applied to iron work it is a visual indicator of the running condition of a machine or other apparatus. The paint is red at ordinary temperatures but turns black when heated, becoming red again on cooling. It is claimed that the color will always follow the temperature, no matter how many times the cycle is repeated.—*Iron Age.*

Metric System in China.—China recently enacted a weights and measures law in which the meter and kilogram are prescribed as the sole standards, although the old system of measures is still recognized. The units of the old system are defined in metric terms, the length unit being exactly 32 centimeters. The metric units are given the same names in the Chinese language as the nearest old units, but to each is given the prefix "sin," which means "new." Thus the meter will be known as "sin-tchi," and the kilogram as "sin-king." The metric system was not made compulsory at the outset, the date of compulsory application of the act being fixed later.

RECIPROCATING AND REVOLVING PARTS

Beginning a Series of Articles Dealing With Their Design and Improvements Which Are Possible

BY H. A. F. CAMPBELL*

I—AMERICAN DESIGN

The late S. L. Barnes once said "The practical problem of balancing is not one of how to balance, but of reducing the total weight of the reciprocating parts to a minimum."

The size of the present day passenger and freight locomotive has made it more necessary than ever to keep the weight of the reciprocating parts down to a minimum. A certain Pacific type locomotive now in service has a piston and piston rod weighing 900 lb., a crosshead 560 lb., and a main rod 970 lb. When this engine is running a mile a minute, the force of the inertia of these reciprocating weights at the end of each stroke is about 80,000 lb. or 40 tons. The excess weight in each driver to balance two-thirds of these reciprocating parts causes a dynamic augment on the rail 50 per cent greater than the static weight on each wheel. This means a total variation between the maximum and the minimum weight of 100 per cent of the static weight on any wheel point. The inertia of these reciprocating weights acts at a distance of three feet from the center line of the locomotive, producing a large unbalanced couple tending to nose the engine. Even the revolving weights in the main wheels, owing to their size, are far out of the plane of their balance weight in the wheel. This creates another unbalanced couple that tends to rock the axle across the engine.

The amount of steam force necessary to accelerate or decelerate these reciprocating masses reduces the evenness of the final turning moment at the crank pin. This reduces the effective drawbar pull, especially at high speeds.

The American railways seem to have decided that the two-cylinder locomotive is a necessity, and to have given up any idea of utilizing three or four cylinders. That is, no matter how great the power to be developed, it has got to be carried by only two sets of driving gear. To do this means that the engine has got to carry as much as 150,000 lb., or 75 tons, on one set of driving gear, consisting of a piston, piston rod and crosshead, wrist pin, main and side rods and crank pins. The largest freight locomotives now have 13 in. diameter main axles and 10½ in. diameter main crank pins; a few years ago the dimensions of this pin would have been considered sufficient for a good-sized axle. If the weight of the parts necessary to carry such loads is to be kept anywhere within reason, great care and refinement in design is imperative. Even then the weights may be too great, and a study of the further reduction of weight by the use of heat treated carbon steel, or of alloy steels, will become necessary.

Before studying in detail the actual present practice in the design of these parts I wish to present a few tables of weights in order to show that the average practice of today is not nearly as good as it was 15 years or more ago. This may seem surprising, but it is a fact. Broadly speaking, the weight of the piston, piston rod, crosshead and connecting rod should be proportional to the piston load that they have to carry. The tables, I to V, give data connected with the reciprocating parts of a

*Baldwin Locomotive Works, Philadelphia, Pa.

TABLE I, DATA FOR RECIPROCATING PARTS OF FREIGHT LOCOMOTIVES BUILT BEFORE 1904

Road and type	Cylinders and driving wheels	Boiler pressure, lb.	Piston load, lb. (area piston x full b. press.)	Weight, lb. Cross-head	Weight, lb. Piston and rod	Weight, lb. Main rod	Total wt. of reciprocating parts, lb.	Piston load carried, lb. per lb. wt. rec. parts	per lb. wt. crosshead	per lb. wt. piston	per lb. wt. main rod
Penn., 2-8-0	22 in. x 28 in.; 57 in.	205	77,900	284	407	615	967	**80**	**274**	**191**	**126**
Nat. of Mexico, 2-8-0	21 in. x 30 in.; 56 in.	200	69,200	365	433	795	1,155	60	189	160	87
Southern Pacific, 2-8-0	22 in. x 30 in.; 57 in.	200	76,000	343	516	750	1,196	63	221	147	101
Mex. Inter., 2-8-0	22 in. x 28 in.; 57 in.	200	76,000	365	537	835	1,280	59	208	141	91
B. R. & P., 2-8-0	22 in. x 28 in.; 56 in.	200	76,000	352	437	942	1,213	62	216	173	80
Woodward Iron Co., 2-8-2	22 in. x 28 in.; 51 in.	200	76,000	567	392	745	1,294	59	134	194	102
Average		...	.....	...	...	...	...	64	207	167	98

TABLE II, DATA FOR RECIPROCATING PARTS OF FREIGHT LOCOMOTIVES BUILT SINCE 1904

Road and type	Cylinders and driving wheels	Boiler pressure, lb.	Piston load, lb. (area piston x full b. press.)	Weight, lb. Cross-head	Weight, lb. Piston and rod	Weight, lb. Main rod	Total wt. of reciprocating parts, lb.	Piston load carried, lb. per lb. wt. rec. parts	per lb. wt. crosshead	per lb. wt. piston	per lb. wt. main rod
C. B. & Q., 2-10-2	30 in. x 32 in.; 60 in.	175	123,700	706	1,022	1,305	2,315	53	175	121	94
C. B. & Q., 2-8-2	28 in. x 32 in.; 64 in.	180	110,900	706	860	1,238	2,123	52	157	128	90
Virginian, 2-8-2	26 in. x 32 in.; 56 in.	185	98,200	691	715	975	1,845	53	142	137	100
Gt. Northern, 2-8-2	28 in. x 32 in.; 63 in.	170	104,700	616	873	1,060	1,966	53	170	120	99
Lehigh Valley, 2-8-2	27 in. x 30 in.; 56 in.	175	100,000	582	855	1,065	1,916	52	171	117	94
Rock Island, 2-8-2	28 in. x 30 in.; 63 in.	180	110,900	642	1,034	1,110	2,176	51	172	107	**100**
Erie, 2-8-2	28 in. x 32 in.; 63 in.	170	104,700	553	760	1,045	1,785	59	189	137	100
B. & O., 2-8-2	26 in. x 32 in.; 64 in.	190	101,000	576	760	905	1,743	58	175	133	111
A. T. & S. Fe., 2-8-2	25 in. x 32 in.; 57 in.	170	83,500	622	754	932	1,795	46	134	110	89
Woodward Iron Co., 2-8-2	24½ in. x 30 in.; 55 in.	200	94,300	530	665	930	1,613	58	177	141	101
N. O. M. C., 2-8-2	22 in. x 28 in.; 57 in.	185	70,300	408	471	730	1,207	58	149	149	96
B. & O., 2-10-2	30 in. x 32 in.; 58 in.	190	134,000	812	1,180	1,475	2,656	49	165	113	90
Average		...	.....	...	...	...	...	53½	165	126	97

TABLE III, DATA FOR RECIPROCATING PARTS OF PASSENGER LOCOMOTIVES BUILT BEFORE 1904

Road and type	Cylinders and driving wheels	Boiler pressure, lb.	Piston load, lb. (area piston x full b. press.)	Weight, lb. Cross-head	Weight, lb. Piston and rod	Weight, lb. Main rod	Total wt. of reciprocating parts, lb.	Piston load carried, lb. per lb. wt. rec. parts	per lb. wt. crosshead	per lb. wt. piston	per lb. wt. main rod
Penn., 4-4-0	18½ in. x 26 in.; 68 in.	185	50,000	169	266	373	568	**88**	**300**	**188**	**134**
D. L. & W., 4-4-0	20 in. x 26 in.; 69 in.	185	58,000	188	390	595	816	71	308	148	97
N. R. R. Mexico, 4-6-0	20 in. x 26 in.; 68 in.	200	62,800	322	372	670	995	63	195	169	93
C. & A., 4-4-2	20 in. x 26 in.; 81 in.	200	62,800	343	453	718	1,119	56	183	137	88
U. P., 4-6-2	22 in. x 28 in.; 77 in.	200	76,000	343	502	725	1,171	65	221	151	105
A. & B., 4-6-0	19 in. x 26 in.; 63 in.	180	51,000	265	357	515	853	59	192	143	100
C. & A., 4-4-2	20 in. x 28 in.; 80 in.	200	62,800	365	429	795	1,152	54	172	146	79
P. & R., 4-4-2	21 in. x 24 in.; 84 in.	220	76,000	352	437	942	1,213	63	216	174	80
C. & A., 4-6-2	22 in. x 28 in.; 80 in.	200	76,000	365	560	805	1,287	60	208	136	94
N. Y. N. H. & H., 4-6-0	20 in. x 26 in.; 73 in.	200	62,800	298	476	766	1,121	56	210	132	82
N. Y. C. & St. L., 4-6-0	20 in. x 26 in.; 72 in.	200	62,800	330	405	726	1,062	59	190	155	96
Average		...	.....	...	...	...	...	63	218	153	95

TABLE IV, DATA FOR RECIPROCATING PARTS OF PASSENGER LOCOMOTIVES BUILT SINCE 1904

Road and type	Cylinders and driving wheels	Boiler pressure, lb.	Piston load, lb. (area piston x full b. press.)	Weight, lb. Crosshead	Weight, lb. Piston and rod	Weight, lb. Main rod	Total wt. of reciprocating parts, lb.	Piston load carried, lb. per lb. wt. rec. parts	Piston load carried, lb. per lb. wt. crosshead	Piston load carried, lb. per lb. wt. piston	Piston load carried, lb. per lb. wt. main rod
Penn., 4-6-2	26 in. x 26 in.; 80 in.	205	109,000	491	650	1,065	1,624	67	215	169	102
C. C. & O., 4-6-2	25 in. x 30 in.; 69 in.	200	98,000	535	670	925	1,613	60½	183	146	106
N. Y. N. H. & H., 4-6-2	24 in. x 26 in.; 79 in.	200	83,000	369	640	922	1,423	58½	225	130	90
C. G. W., 4-6-2	25 in. x 28 in.; 73 in.	190	93,300	493	742	886	1,633	57	190	125	105
C. & O., 4-6-2	27 in. x 28 in.; 73 in.	185	105,800	561	907	971	1,905	55	188	116	109
B. & O., 4-6-2	24 in. x 28 in.; 76 in.	190	85,900	595	660	890	1,655	51½	144	130	103
N. Y. C., 4-6-2	26 in. x 28 in.; 79 in.	200	106,200	585	787	920	1,786	48½	180	134	115
Lehigh Valley, 4-6-2	25 in. x 28 in.; 77 in.	210	103,000	445	704	850	1,531	67	231	146	121
Average		...	.....	...	...	...	...	58	194	137	106

TABLE V, DATA FOR RECIPROCATING PARTS OF LOCOMOTIVES BUILT IN 1914, WITH ESPECIALLY LIGHT PARTS

Road and type	Cylinders and driving wheels	Boiler pressure, lb.	Piston load lb. (area piston x full b. press.)	Weight, lb. Crosshead	Weight, lb. Piston and rod	Weight, lb. Main rod	Total wt. of reciprocating parts, lb.	Piston load carried, lb. per lb. wt. of rec. parts	Piston load carried, lb. per lb. wt crosshead	Piston load carried, lb. per lb. wt. piston	Piston load carried, lb. per lb. wt. main rod	Reference for photograph
Penn., 4-6-2	27 in. x 28 in.; 80 in.	205	114,000	491	520	930	1,376	83	320	219	122	.....
Penn., 4-4-2	23½ in. x 26 in.; 80 in.	205	89,000	327	408½	720	1,014	87	271	218	123	Fig. 1
Penn., 2-8-2	27 in. x 30 in.; 62 in.	205	114,000	532	516	939	1,470	77	214	220	121	Fig. 2
P. & R., 4-4-0	21 in. x 24 in.; 68½ in.	220	76,200	302	464	590	1,031	74	252	164	130	Fig. 30
C. B. & Q., 2-10-2	30 in. x 32 in.; 60 in.	175	123,700	526	945	1,035	1,936	64	235	130	119	Fig. 19
Average		...	.....	...	...	...	...	77	258	190	123	....

number of locomotives; then follows the most important part—the amount of piston load carried per pound of weight of the parts collectively and of each part separately. The average figures are given at the bottom of each table. The tables have been divided into passenger and freight locomotives built before 1904 and since 1904, and a fourth table is given including five engines built recently, in which exceptional care has been taken in the matter of designing the reciprocating and revolving parts.

If the reader grasps the substance of these tables, it will enable him, without going over a lot of data, to see that we are not doing as well in respect to the design of reciprocating parts, as we did in the past on smaller engines. An examination of the first engine given in each table, freight and passenger, will show cases before 1904 that are so far above the average as to be striking; and one of the passenger engines is not only above the average, but it is better in nearly every weight per load carried *unit of work done may be reduced. Light parts do not necessarily mean weak parts, but may mean stronger parts.*

The designers of the automobile and the flying machine, by using great care in detail design, and by the use of high grade steel, have reduced the weight of their moving parts to a marvelous degree. The locomotive engineer can do the same when he makes up his mind that it is necessary and decides to start anew, determined to obtain definite results in weight reduction. In the remainder of this article it is the intention to show in detail the notable results obtained in the design of the reciprocating parts of several locomotives built in 1914.

The Pennsylvania Railroad in 1914 built very heavy and powerful Atlantic (see Fig. 1) and Pacific type locomotives,* both of which have a very heavy weight on drivers. To safely permit the use of such a weight it was imperative that the excess counterbalance weight in the drivers should not exceed a certain figure at a given speed. It was determined that at 70 miles per

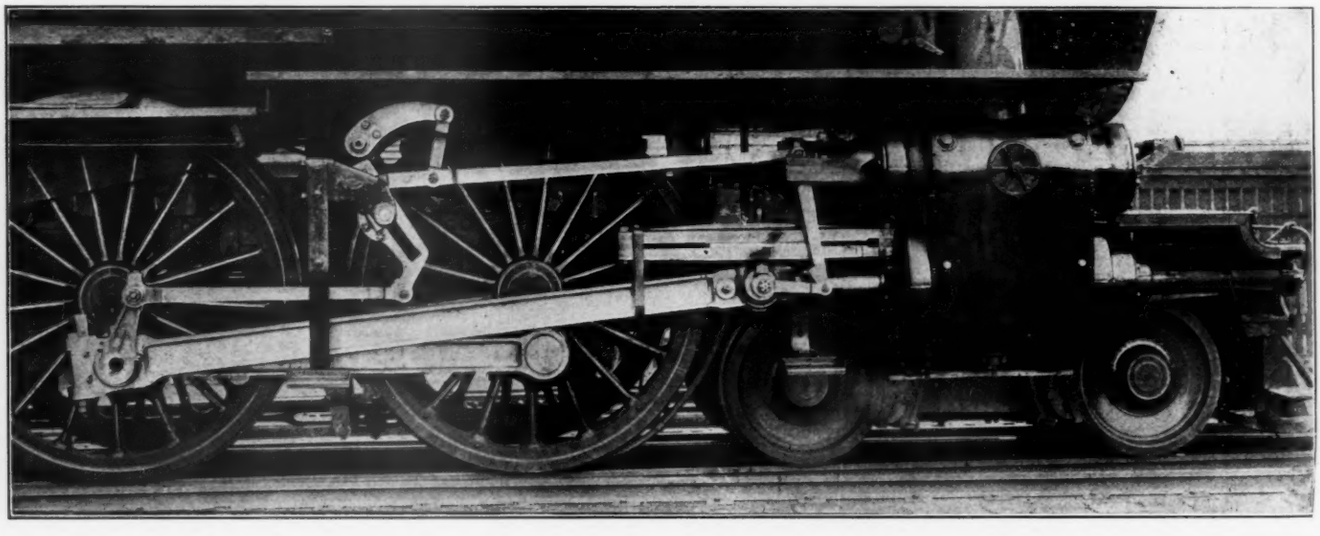


Fig. 1—Running Gear of Pennsylvania Railroad Atlantic Type Locomotive, Class E6s

than any of the recent five cases of special locomotives given in the last table. A great many of this class of 4-4-0 type locomotives have been built and are still running, and I feel safe in saying have shown no failures in these light parts.

This brings us to the main thought which the writer wishes to bring out in this paper, and to a fact that each reader should consider carefully. *As the size and power of the locomotive is increased, the moving parts per unit of work to be done need not be increased in weight. On the contrary their weight per* hour the centrifugal force of the excess weight in the driving wheels should not exceed 30 per cent of the static weight on a wheel point; or, to state it another way, the variation between the maximum weight and the minimum weight on a driver should not exceed 60 per cent of the static weight. This definitely

*A description of the Pennsylvania Atlantic type locomotive, class E6s, was published on page 63 of the *Railway Age Gazette, Mechanical Edition*, for February, 1914, and a description of the Pacific type locomotive, class K4s, and the Mikado type, class L1s, Fig. 2, was published on page 343 of the July, 1914, issue.

settled what the reciprocating parts must weigh, and in order to bring the weight of the parts within this limit it was found that only 60 per cent of the reciprocating parts could be balanced. The weights of these parts are given in table VI.

TABLE VI—WEIGHTS OF RECIPROCATING PARTS OF PENNSYLVANIA LOCOMOTIVES

Name of part	Weight, lb. Atlantic, E6s	Pacific, K4s
Piston, piston rod, extension rod, crosshead and key	408.5	520
Crosshead and wrist pin	312	480
Lap and lead lever connector	15	11
Front end of main rod	279.5	365
Back end of main rod	440.5	565
Total main rod	720	930
Front end of side rod	186	136
Back end of side rod	231	162.5
Side rod (main pin)	.....	534.5
Rear end eccentric rod (equivalent at 13 in. radius)	22.7	.....

The material for the main and side rods, piston rod, pins and valve motion parts is silico-manganese carbon steel, heat treated, with the following characteristics:

Carbon .....0.50 per cent	Ultimate strength.85,000 lb. per sq. in.
Manganese .....0.55 per cent	Elastic limit.....50,000 lb. per sq. in.
Silicon .....0.20 per cent	Elongation in 2 in.....20 per cent
Phosphorus ...Not over 0.03 per cent	Reduction in area.....40 per cent
Sulphur .....Not over 0.03 per cent	

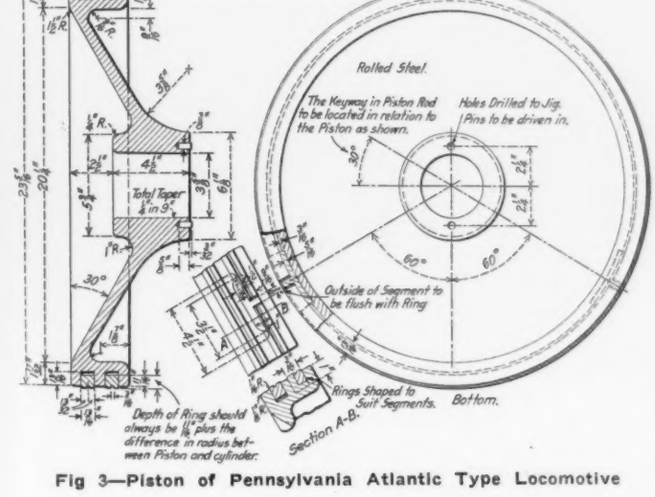

The Piston Rings should be turned 1/8" larger in diameter than bore of cylinder and then cut to fit cylinder.
Rolled Steel.
The Keyway in Piston Rod to be located in relation to the Piston as shown.
Holes Drilled to Jig. Pins to be driven in.
Total Taper 1/4 in 9"
Outside of Segment to be flush with Ring
Rings Shaped to Suit Segments.
Bottom.
Depth of Ring should always be 1/16" plus the difference in radius between Piston and cylinder.
Section A-B.

Fig 3—Piston of Pennsylvania Atlantic Type Locomotive

The pistons are made of rolled open hearth carbon steel. The crossheads are of cast steel made by the electric furnace process, with the following qualities:

Carbon .....0.40 per cent	Ultimate tensile strength,
Manganese .....0.48 to 0.60 per cent	70,000 to 80,000 lb. per sq. in.
Silicon .....0.22 to 0.28 per cent	Elongation in 2 in..12 to 25 per cent

Until a designer has actually tried, he does not realize what it means to produce such light parts and still retain the required strength. Figs. 3, 4, 5, 6 and 7 show the piston, piston rod, crosshead, main rod and side rods for the Atlantic type locomotive class E6s, and Figs. 8, 9, 9A, 10, 11 and 12 for the Pacific type, class K4s. The unit stresses have been noted on the drawings at the different sections. They are based on a maximum piston load equal to the product of the area of the piston and the full boiler pressure and a proportion of the main rod load on the side rods, in the case of the Atlantic type 80 per cent, of the Pacific type 70 per cent.

The pistons are of rolled steel of umbrella shape and are of extremely light section. The unit stress has not been determined, as there is no really satisfactory formula for the design of pistons. Unwin's, Seaton's and Bach's formulas are all well known, and the designer may possibly use them all as a guide; but in the last analysis he must use his judgment, especially with this shape of piston, as it is known to be actually stronger than any of the formulas will show. It will be noted that no cast iron wearing shoe is used, and that the wearing surface of the rim is only 3½ in. wide, but the piston rod has an extension tail rod. If the extension rod had not been used, the employment of such a narrow wearing surface as 3½ in. would hardly have seemed wise, and it is possible that a cast iron bull-ring might have had to be used. But with a wider ring made of cast iron, and no extension tail rod, the weight would have been greater than the piston head, even allowing for the added weight of the extension piston rod and the sliding shoe. There is a belief that an extension piston rod, unless it is very stiff and kept carefully lined up, is of little value, but a hollow extension rod of large diameter can be made stiff and at the same time very light.

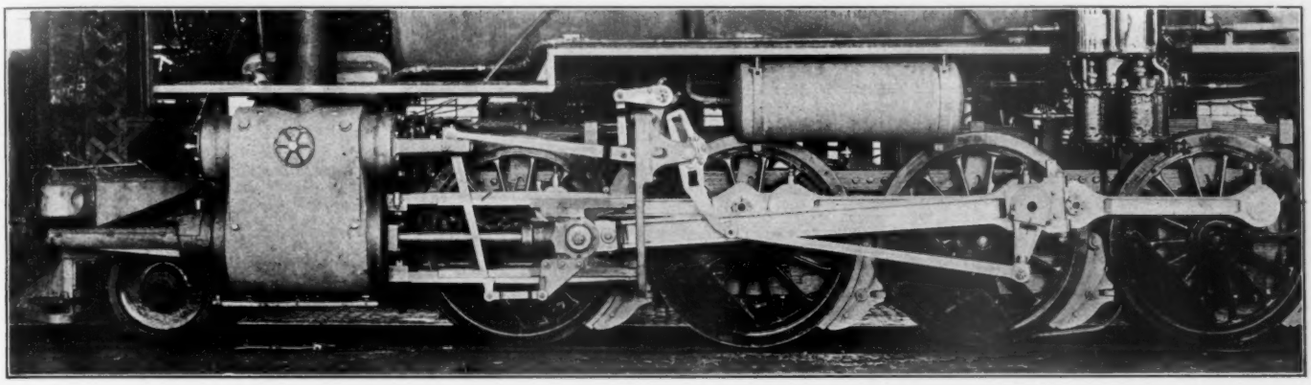


Fig 2—Running Gear of Pennsylvania Railroad Mikado Type Locomotive, Class L1s

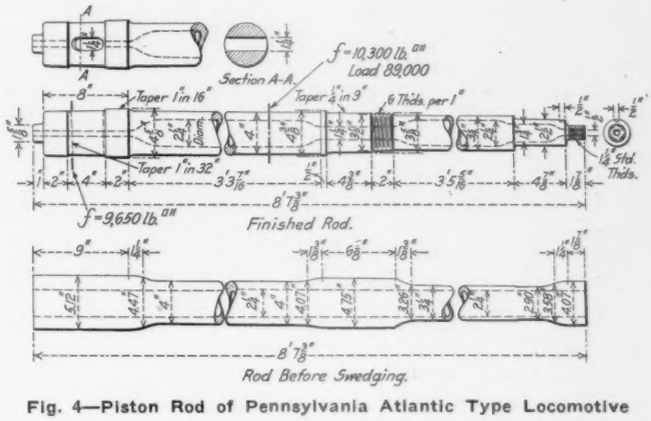


Fig. 4—Piston Rod of Pennsylvania Atlantic Type Locomotive

The details of the piston rod and its extension and the rod extension shoe are clearly shown in Figs. 4, 9 and 9A. These rods are made of carbon steel, heat treated. The method of manu-

facture is clearly shown; the rod is forged and then hollow bored throughout its length. The necessary sections are then swaged down as shown in the finished rod. The load and unit stresses are noted. Although this rod is extremely light, it is stiff in compression and flexure, and there should be no reason for its causing trouble.

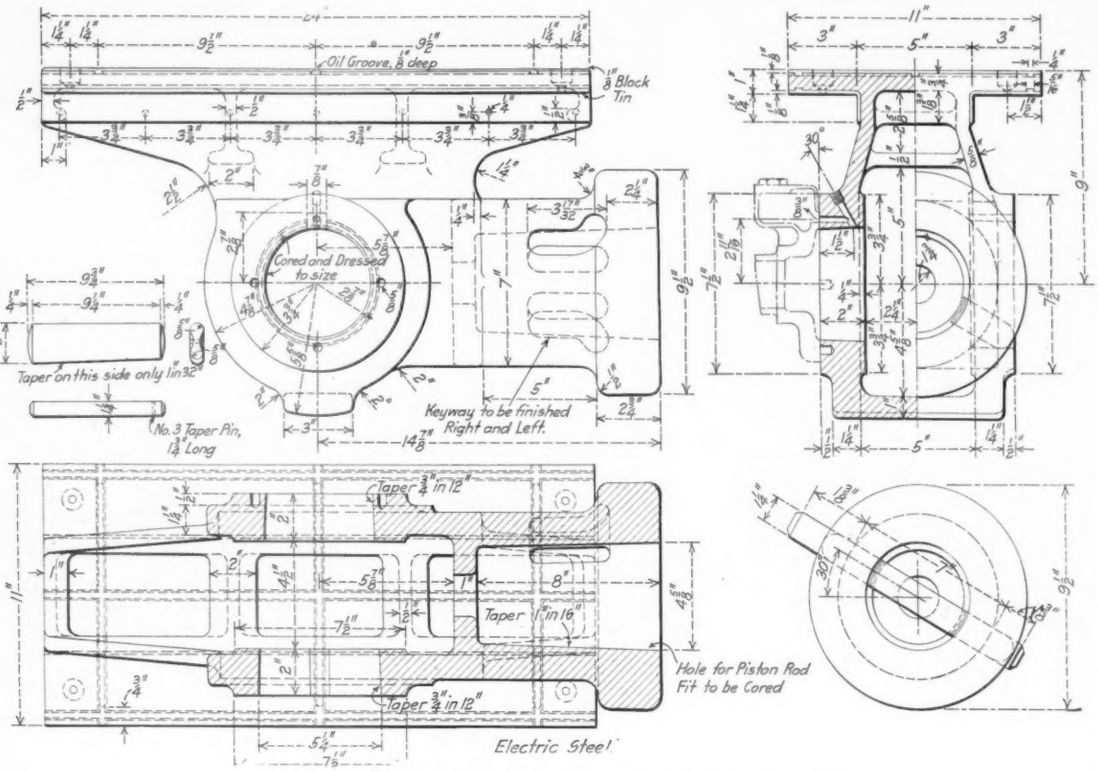

Oil Groove, ⅛ deep
⅛ Block Tin
Cored and Dressed to size
Taper on this side only 1 in 32
No. 3 Taper Pin, 1¾ Long
Keyway to be finished Right and Left.
Taper ¾ in 12
Taper 1 in 16
Hole for Piston Rod Fit to be Cored
Electric Steel

Fig. 5—Crosshead of Pennsylvania Atlantic Type Locomotive

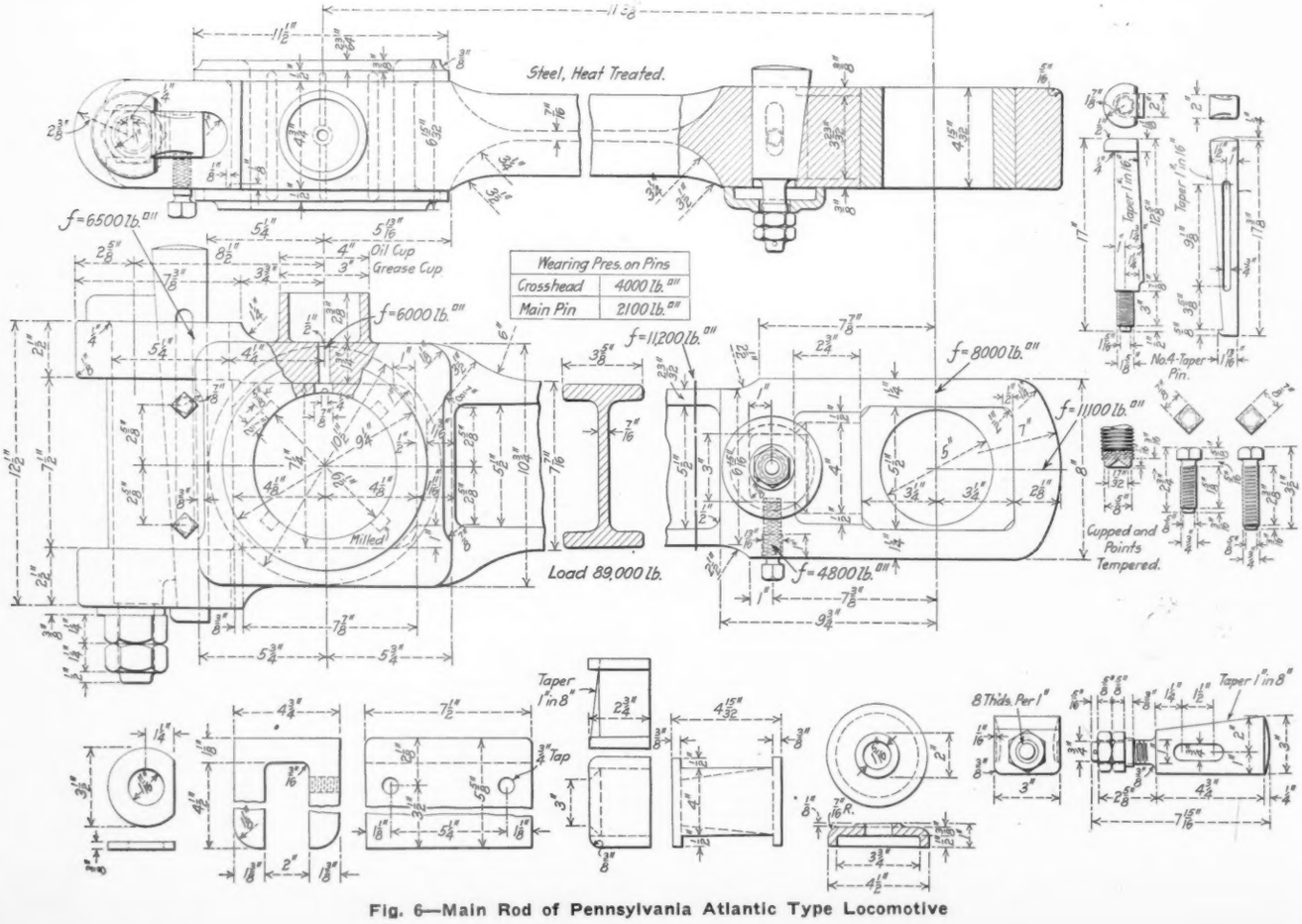


Fig. 6—Main Rod of Pennsylvania Atlantic Type Locomotive

The crossheads are shown in Figs. 5 and 10. This type of crosshead has been standard on the passenger engines of the Pennsylvania Railroad and on many New Haven engines for

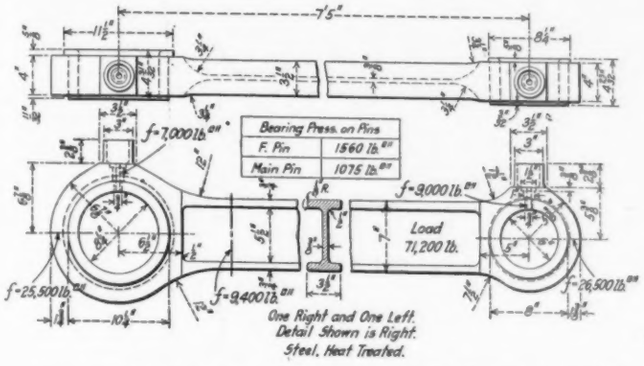

Bearing Press. on Pins
F. Pin 1560 lb.
Main Pin 1075 lb.
Load 71,200 lb.
One Right and One Left. Detail Shown is Right. Steel, Heat Treated.

Fig. 7—Side Rod of Pennsylvania Atlantic Type Locomotive

years. With the exception of the old style crosshead with a solid wrist pin and using four-bar guides, as shown in Fig. 9B, it is the lightest type of crosshead made, in relation to its strength.

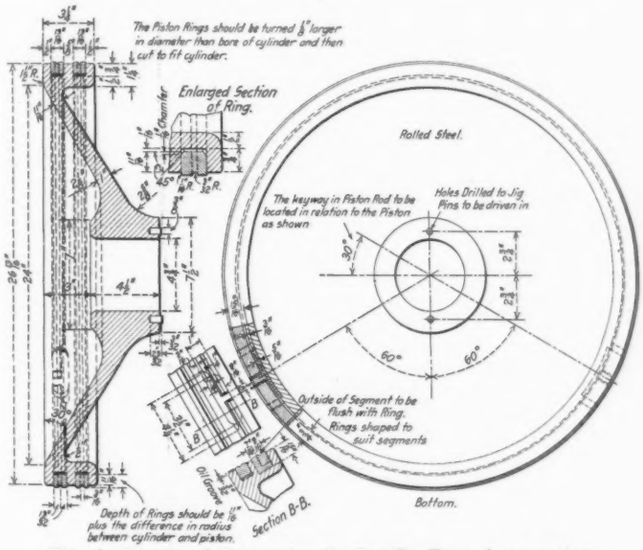
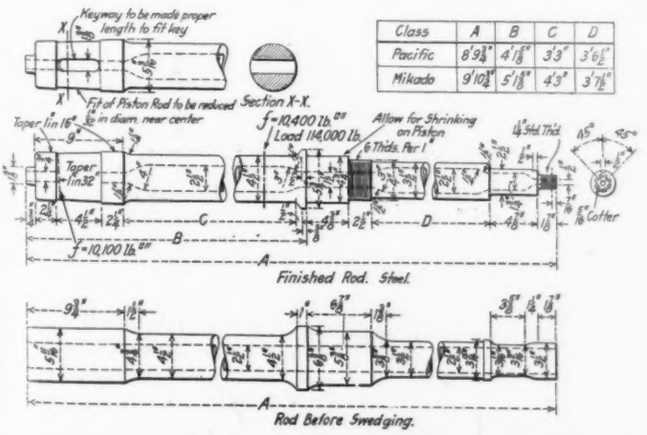

The Piston Rings should be turned 1/8" larger in diameter than bore of cylinder and then cut to fit cylinder.
Enlarged Section of Ring.
Rolled Steel.
The keyway in Piston Rod to be located in relation to the Piston as shown
Holes Drilled to Jig. Pins to be driven in
Outside of Segment to be flush with Ring. Rings shaped to suit segments
Depth of Rings should be 1/16 plus the difference in radius between cylinder and piston.
Section B-B.
Bottom.

Fig. 8—Piston of Pennsylvania Pacific Type Locomotive

These crossheads are made of 0.4 carbon steel by the electric furnace process, and the railway officers state that this is the


Keyway to be made proper length to fit key
Fit of Piston Rod to be reduced 1/16 in diam. near center
Taper 1 in 16
Taper 1 in 32
Section X-X.
f=10,400 lb.
Load 114,000 lb.
6 Thds. Per 1"
Allow for Shrinking on Piston
1/4" Std. Thd.
5/16" Cotter
f=10,100 lb.
Finished Rod. Steel.
Rod Before Swedging.

Class	A	B	C	D
Pacific	8'9 3/8"	4'1 3/8"	3'3"	3'6 1/2"
Mikado	9'10 1/4"	5'1 3/8"	4'3"	3'7 1/2"

Fig. 9—Piston Rod of Pennsylvania Pacific Type Locomotive

only method that insures these castings being sound. The unit stresses on the various sections are given in Table VII and are based on a load equal to the area of the piston times the full boiler pressure. These stresses are conservative.

TABLE VII—STRESSES IN PISTON ROD AND CROSSHEAD OF PENNSYLVANIA LOCOMOTIVES

Section; and nature of stress	Amount of stress, lb. per sq. in. Atlantic type, E6s	Pacific type, K4s
Shear on key	10,500	10,900
Tension in rod through keyway	9,650	10,500
Tension in neck of crosshead through keyway	4,700	3,550
Crushing of key on the rod	16,500	17,800

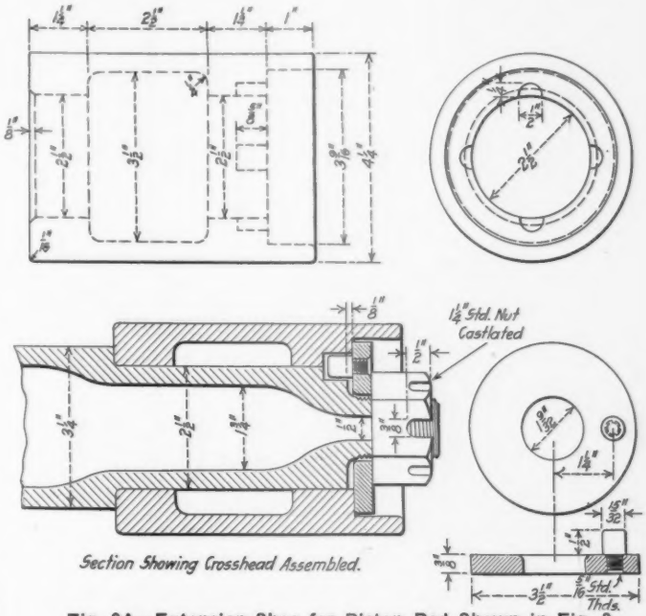


Fig. 9A—Extension Shoe for Piston Rod Shown in Fig. 9

Crushing of key on crosshead	16,200	13,800
Bearing pressure, pin on crosshead	4,450	4,600
Compression in main shank of piston rod	10,300	10,400

The crossheads have ample gib surface and bearing surface where the pin bears on the crosshead, a very essential point. The oiling of the wrist pin has been carefully worked out and is clearly shown in the drawings. The lap and lead connecting link is driven from an extension of the wrist pin. Studying these cross-

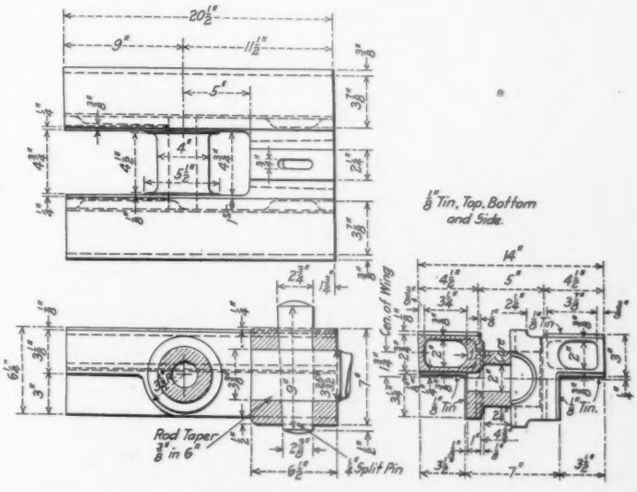


Fig. 9B—Four-bar Crosshead

heads in detail it will be found that no unnecessary metal has been put into them; the one point that may be raised is that they are not as strong when the engine is running backwards and therefore are unsuitable for freight engines.

The main and side rods for the Atlantic type, class E6s, are shown in Figs. 6 and 7, and for the Pacific type, class K4s, in

Figs. 11 and 12. These rods are made of open hearth carbon steel, heat treated. The loads and unit stresses at the different sections are noted on the drawings and are given in table VIII.

Great care has been given to every detail of these rods. The back stub of the main rod follows the railway's standard practice. This is a strong, light stub, but the writer does not believe that it can be made any lighter than a stub that uses a strap and bolts. The side rods have been made unusually deep, giving a

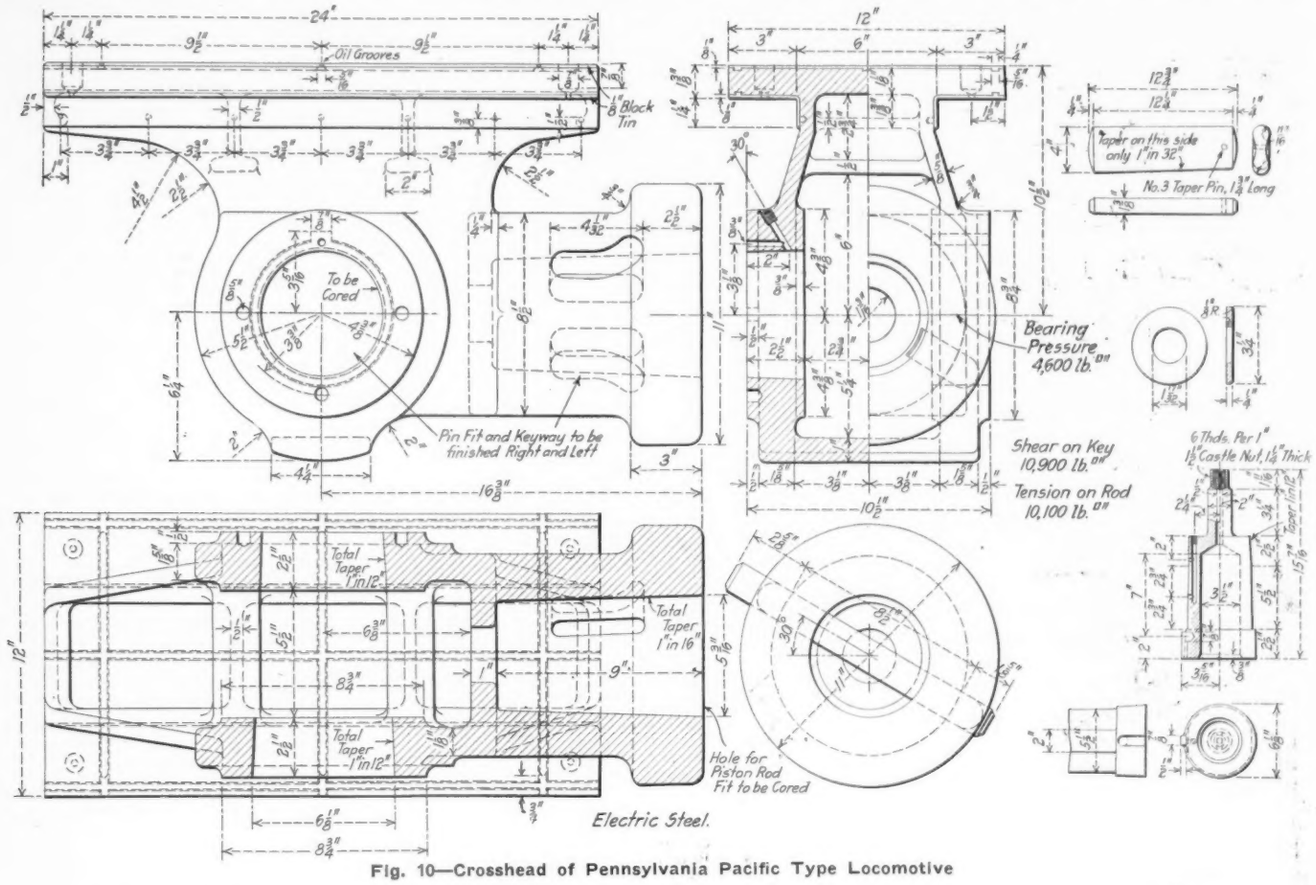
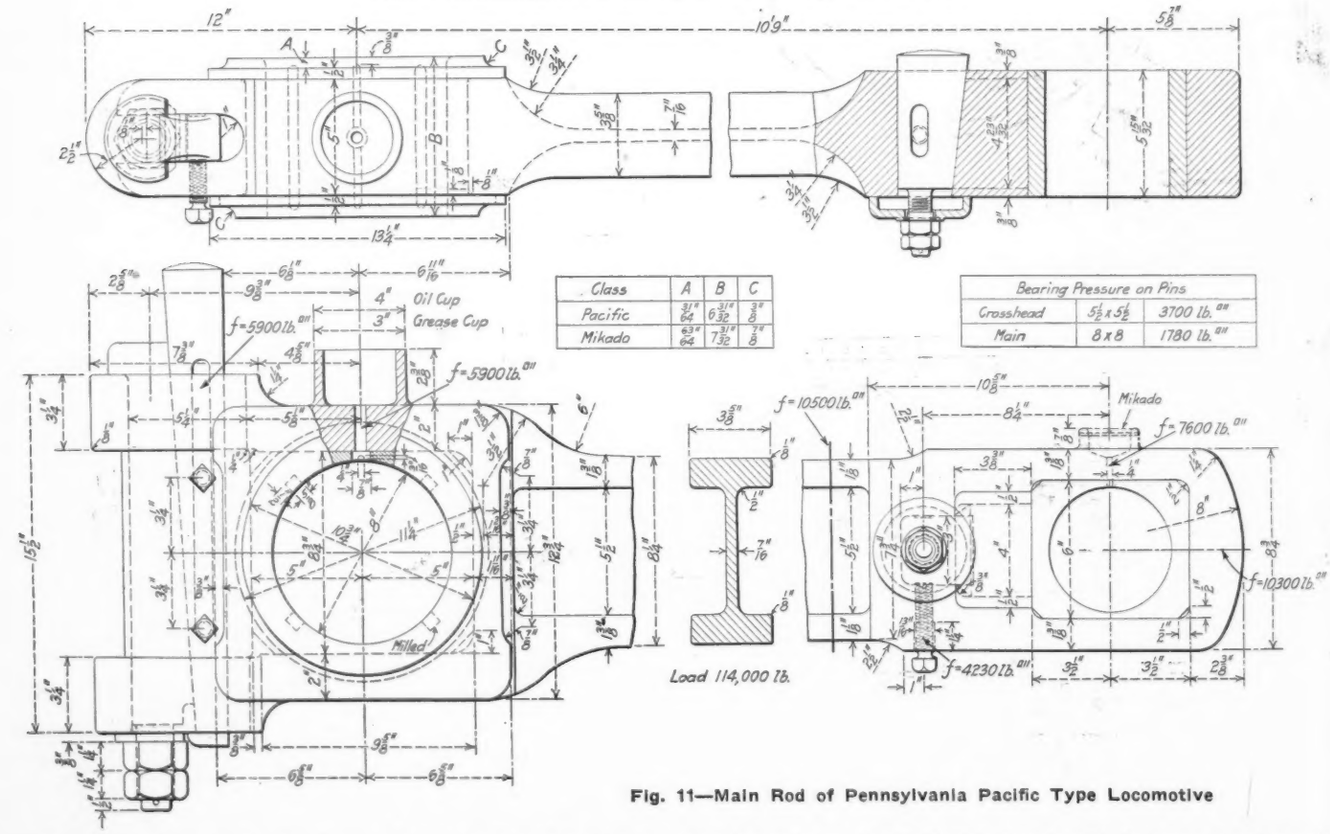

Oil Grooves
To be Cored
Pin Fit and Keyway to be finished Right and Left
Bearing Pressure 4,600 lb.
Shear on Key 10,900 lb.
Tension on Rod 10,100 lb.
Taper on this side only 1" in 32"
No. 3 Taper Pin, 1¾" Long
6 Thds. Per 1"
1½" Castle Nut, 1¼" Thick
Total Taper 1 in 12"
Total Taper 1" in 16"
Hole for Piston Rod Fit to be Cored
Electric Steel.

Fig. 10—Crosshead of Pennsylvania Pacific Type Locomotive



Class	A	B	C
Pacific	31/64"	6 31/32"	3/8"
Mikado	63/64"	7 31/32"	7/8"

Bearing Pressure on Pins		
Crosshead	5½ x 5½	3700 lb.
Main	8 x 8	1780 lb.

Fig. 11—Main Rod of Pennsylvania Pacific Type Locomotive

correspondingly low whip stress at high speeds. The knuckle pin of the side rods, Fig. 12, seems unusually large, but this size is used to keep the bearing pressure per square inch down to

TABLE VIII—STRESSES IN MAIN AND SIDE RODS OF PENNSYLVANIA LOCOMOTIVES

Section; and nature of stress	Amount of stress, lb. per sq. in. Atlantic type, E6s	Pacific type, K4s
Main rod, I section	11,200	10,500
Crosshead stub, tension	8,000	7,600
Crosshead stub, bending	.....	10,500
Main stub strap, tension	6,000	5,900
Side rod, I section	9,400	10,600
Front and back stub eye, tension	9,000	9,400
Front and back stub eye, bending	26,500	31,700
Main side rod stub, tension	.....	7,500
Main knuckle eye, tension	.....	10,100

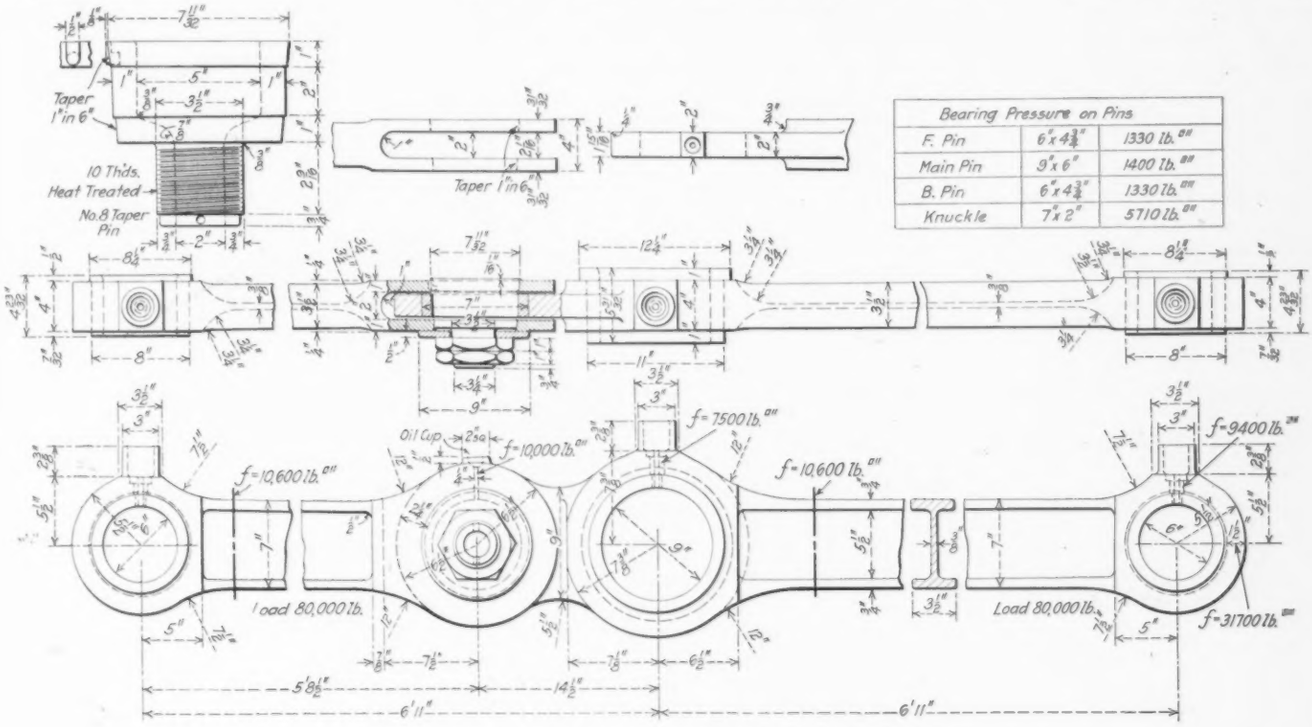


Fig. 12—Side Rods of Pennsylvania Pacific Type Locomotive

standard practice. Knuckle pins are often made too small and show very rapid wear because of lack of ample bearing surface. Another point in favor of this knuckle pin is that, being large in diameter and narrow, it gives an action more like a spherical pin. This is important because there is no doubt that many side rod failures are due to a twisting action on the rods, produced by the rod ends getting out of line with each other. A ball knuckle pin will greatly relieve this cross twisting strain. The I sections of the rods are broad, and slim, a type of section that has been extensively used on the road.

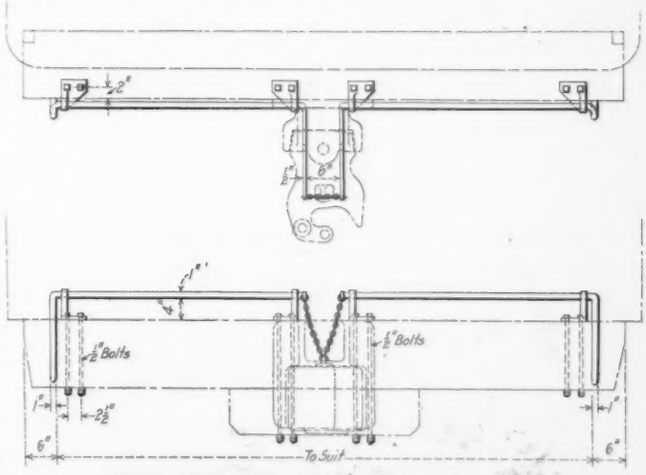
[EDITOR'S NOTE.—The remaining section of Part I of this series will be published in an early issue.]

HARDNESS TESTING.—If in testing for hardness by the Brinell process it is necessary to use a V-block when testing the bar, see that the block is made of tool steel well hardened and tempered to a straw color, otherwise an impression of the bar will be left in the block and a true Brinell will not be obtained. Small bars, ⅝ in. and less in diameter, usually give an exaggerated result lower than that obtained from the same steel in heavier bars; want of surrounding stiffness explains this. When testing malleable castings or intricate pieces, take several impressions in various places and then work out the mean result; otherwise the test may be misleading.—*American Machinist.*

UNCOUPLING LEVER FOR SWITCH ENGINES

BY GEORGE E. McCOY

A design of uncoupling lever which is being successfully used on the front and rear ends of switch engines on the Intercolonial Railway is shown in the accompanying drawing. It replaces the old style of lever which extend across the locomotive in one piece with an operating handle at either end. The old style lever was objected to because of the danger of injury to a person standing near the end of the footboard when the lever was being operated from the opposite end. In the new



Double Uncoupling Lever for Switch Engines

design the lever is in two parts, each of which is separately connected to the lock lifter, thus making the movement of the lever at one end entirely independent of the other.

RAILWAY MEN AND THE WAR.—It is stated that 4,000 employees of the Lancashire & Yorkshire Railway are now in the British army on the continent.

PORTUGUESE EXPRESS LOCOMOTIVE

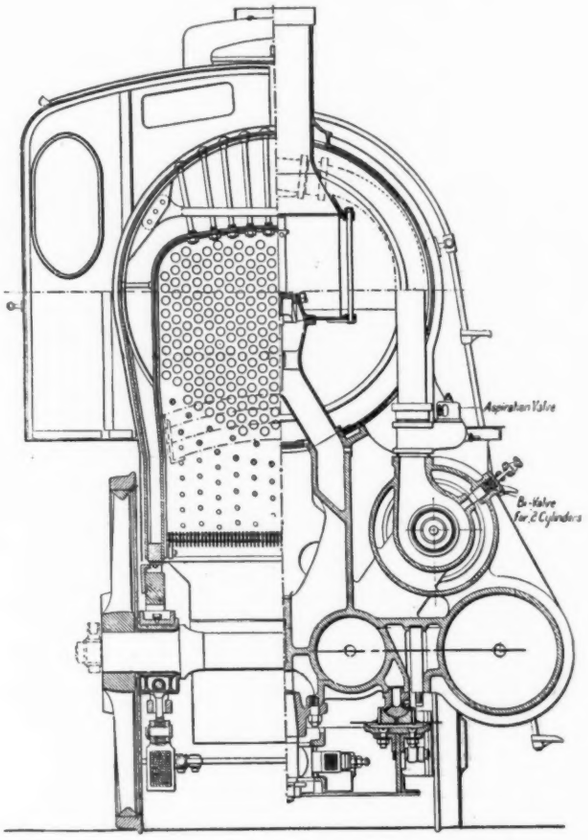
Balanced Compound Ten-Wheel Type Which Develops Exceptionally High Power Per Unit of Weight

The locomotive shown in the illustration was recently built for the Portuguese State Railways for express passenger service, and is of special interest because of the high horsepower developed in relation to the engine's total weight. A maximum indicated horsepower of 2,214 is reported to have been developed with a total weight of 165,000 lb. and a weight on drivers of 112,200 lb. This is equivalent to 1 hp. per 74.5 lb. of total weight and is nearly 40 per cent greater than the horsepower per unit of weight developed by the American Locomotive Company's experimental Pacific type locomotive, No. 50,000. The latter developed 2,216 hp. continuously in actual service, which is equivalent to 1 hp. per each 121.4 lb. of total weight. The Portuguese engine has a maximum tractive effort of 22,200 lb., while the experimental Pacific type locomotive is rated at 40,300 lb.

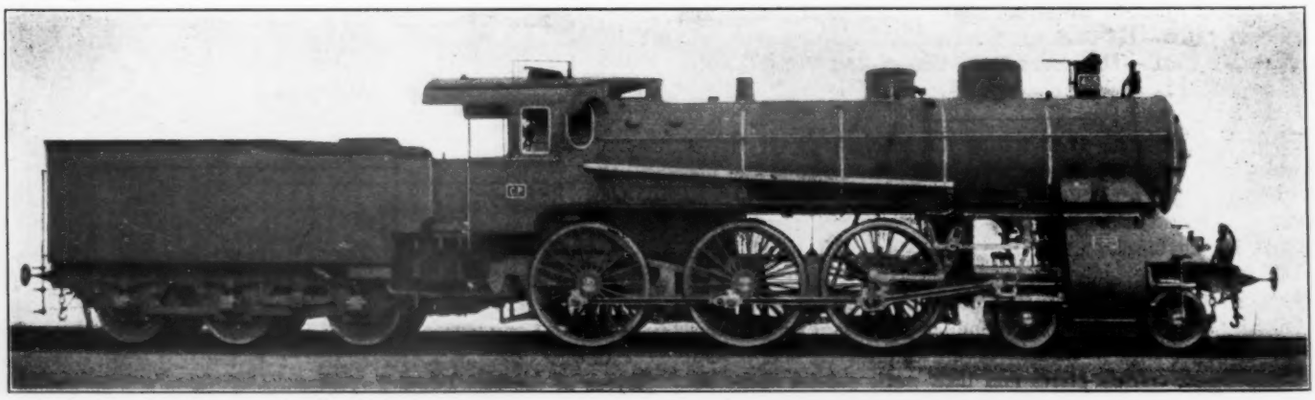
The Portuguese engines are built to operate on a 5 ft. 5¾ in gage, thus increasing the clearance limits and decreasing the difficulties of cylinder and axle design for a balanced compound locomotive. The four cylinders lie in the same horizontal plane, the high pressure being placed between the frames and the low pressure outside of the frames. The high pressure cylinders are 15.35 in. in diameter, while the low pressure have a diameter of 24.8 in., giving a cylinder ratio of 2.61. Both high and low pressure cylinders drive on the front pair of wheels, the former through a crank axle. The steam distribution is controlled by two piston valves of somewhat unusual construction. By referring to the sectional elevation of the locomotive it will be seen that each valve is made up of three heads, mounted upon the same stem, each head being surrounded by an annular cavity enclosed by packing rings at the ends. The central head, which is considerably smaller in diameter than the others, controls the steam admission to and exhaust from the high pressure cylinders. Each end of the valve serves one end of the low pressure cylinder, the annular cavities around the valve forming a portion of the final exhaust from the low pressure cylinder to the atmosphere.

Three poppet inlet valves are provided on each valve chest, and are connected with the reversing gear in such a manner that when in full forward or starting position all three valves are opened. The central valve admits steam from the high pressure steam cavity to a cored passage in the cylinder casting while the two end valves simultaneously admit the steam from this passage into the cavity below each low pressure steam port. The admission of live steam is therefore automatic, the object being to bring the low pressure cylinders immediately into service in order to quickly start the engine. This arrangement prevents the accumulation of the undue back pressure on the high pressure piston which results from the use of the ordinary by-pass starting valve operated independently from the cab and by providing a steam passage to the low pressure cylinders which is independent of the high pressure port opening, insures a more rapid accumulation of effective pressure and a quicker starting engine than is possible with the by-pass starting valve.

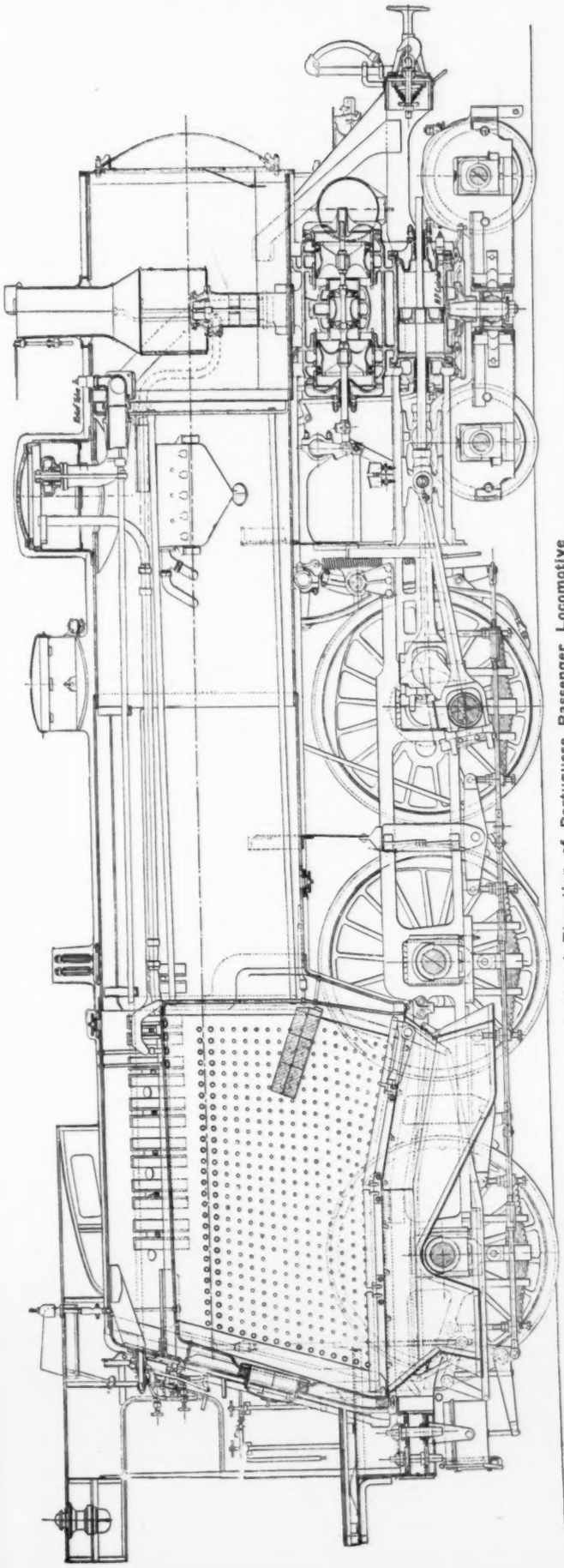
The boiler is of the straight top type having a diameter of 66¼ in. outside of the first ring and carrying a working pressure of 227.5 lb. It has a total heating surface of 2,503 sq. ft. of which 188 sq. ft. or about 7.5 per cent is located in the firebox. Owing to the wide gage an unusual width of firebox is possible



Half Sections Through Cylinders and Firebox



Balanced Compound Express Passenger Locomotive for the Portuguese State Railway



Sectional Elevation of Portuguese Passenger Locomotive

without employing a trailer truck, a grate area of 44.1 sq. ft. being obtained with a length of 123 in.

The engines have bar frames 4 in. wide with a single front rail to which the cylinder castings are secured in the manner commonly employed in American practice. All driving journals are 8⅜ in. in diameter and 9½ in. long.

In service it is said that these engines have completely fulfilled all the required conditions, their performance having proved highly satisfactory in every way. From a number of indicator cards taken in service on a level line at various speeds and cutoffs, the total indicated horsepower varies from 842 at 40 miles per hour with a train of 341 tons and a cutoff of 40 per cent to a maximum of 2,214 at 63 miles per hour while hauling a train of 388 tons and working at a cutoff of 50 per cent. The accompanying table gives the results calculated from five typical indicator cards taken under varying conditions.

HORSEPOWER CALCULATED FROM INDICATOR CARDS

Speed	Boiler pressure	Cutoff	Weight of train	I. Hp.
40 m. p. h.	213 lb.	40 per cent	341 tons	830
56 m. p. h.	213 lb.	38 per cent	341 tons	1,234
62 m. p. h.	203 lb.	35 per cent	355 tons	2,054
63 m. p. h.	227.5 lb.	50 per cent	388 tons	2,214
67 m. p. h.	227.5 lb.	40 per cent	314 tons	1,799

The tender is carried on six wheels, pedestals for which are provided in the underframe. It has a water capacity of 5,800 gal. and carries 9.8 tons of coal. The principal dimensions and ratios of the locomotive are given in the accompanying table:

General Data

Gage	5 ft. 5¾ in.
Service	Passenger
Fuel	Coal
Tractive effort	22,200 lb.
Weight in working order	165,000 lb.
Weight on drivers	112,200 lb.
Weight on leading truck	52,800 lb.
Weight of engine and tender in working order	270,900 lb.
Wheel base, driving	14 ft. 9⅛ in.
Wheel base, total	29 ft. 0½ in.

Ratios

Weight on drivers ÷ tractive effort	5.06
Total weight ÷ tractive effort	7.4
Tractive effort × diam. drivers ÷ heating surface	663.8
Total heating surface ÷ grate area	56.8
Firebox heating surface ÷ tube heating surface, per cent	8.1
Weight on drivers ÷ total heating surface	44.8
Total weight ÷ total heating surface	66.0
Volume equivalent simple cylinders, cu. ft.	7.8
Total heating surface ÷ vol. equivalent simple cylinders	320.9
Grate area ÷ vol. equivalent simple cylinders	5.7

Cylinders

Kind	Balanced compound
Diameter and stroke	15.35 in. and 24.80 in. by 25.20 in.

Valves

Kind	Piston

Wheels

Driving, diameter over tires	74.8 in.
Driving journals, main, diameter and length	8.66 in. by 9.45 in.
Driving journals, others, diameter and length	8.66 in. by 9.45 in.
Engine truck wheels, diameter	35.4 in.

Boiler

Style	Straight top
Working pressure	227.5 lb.
Outside diameter of first ring	66.2 in.
Firebox, length and width	123 in. by 51.2 in.
Tubes, number and outside diameter	300—1.87 in.
Tubes, length	15 ft. 9 in.
Heating surface, tubes	2,314.3 sq. ft.
Heating surface, firebox	188.4 sq. ft.
Heating surface, total	2,502.7 sq. ft.
Grate area	44.1 sq. ft.

Tender

Weight, loaded	105,900 lb.
Water capacity	5,800 gal.
Coal capacity	8.8 tons

GERMAN IRON ORE PRODUCTION.—Germany's iron ore production for 1913 is given by Stahl und Eisen as 35,941,285 metric tons, having a value of 3.71 marks (88.2 cents) per ton as compared with 33,711,142 tons in 1912 with a value of 3.73 marks (88.7 cents) per ton. In 1913 48,047 miners were working as against 46,295 in 1912. Brown iron ore containing less than 12 per cent of manganese constituted 3,005,970 tons of the 1913 total, while the brown ore containing from 12 to 30 per cent manganese amounted to 330,037 tons. Manganese ore of over 30 per cent manganese totaled 760 tons in 1913.—*Iron Age.*

ECONOMIC VALUE OF A LOCOMOTIVE*

Earning Capacity Analyzed; Opportunities for Increased Returns; Improved Shop Methods Prove Economical

BY GEORGE S. GOODWIN
Mechanical Engineer, Chicago, Rock Island & Pacific, Chicago, Ill.

Consideration of the potential value of locomotives, expressed even roughly in terms of average daily earning capacity, suggests several important possibilities for the improvement of general practice, which it is the purpose of this paper to discuss. For the fiscal year ending June 30, 1913, the total operating revenue from 251,277 miles of railroad was $3,181,177,898, divided as follows:

Freight	$2,203,860,284	69.28 per cent
Passenger	716,174,021	22.51 per cent
Other transportation revenue	224,939,393	7.07 per cent
Total revenue from transportation	$3,144,973,698	98.86 per cent
Non-transportation revenue	36,204,200	1.14 per cent
Total revenue from transportation	$3,144,973,698	98.86 per cent

This revenue was produced by the use of 63,198 locomotives having an average tractive effort slightly over 30,000 lb. Assuming that 11 per cent of these locomotives are in the shop receiving repairs, this leaves 56,246 earning the above revenue. Dividing the total revenue from transportation, by the number of engines gives nearly $56,000 per year, or $153 per day as the gross earnings of an engine. Applying to this figure the operating ratio, 71.33, we have $44 per day as the net earning power of all the locomotives of the United States. This money was earned after the locomotive had paid for repairing the track, paid for repairing the cars, and paid for repairing itself.

The most notable thing about these figures is that nearly 99 per cent of the total operating revenue of the railways is received from the operation of trains, for the successful operation of which three essentials are necessary, namely: Locomotives to move the trains, which is the subject of this paper; equipment to carry the tonnage, and track to move the trains on.

No two of these essentials are of any benefit without the third, and the importance of all three is shown by the fact that for the fiscal year ended June 30, 1913, $544,000,000 was spent for maintenance of equipment and $538,000,000 for maintenance of way.

In order to bring out the monetary value of a locomotive a little clearer, statistics are quoted in the accompanying table from 24 of the larger roads of the middle and western states for the fiscal year ending June 30, 1913. The gross earnings of locomotives per day is the quotient of earnings divided by the number of locomotives reduced to a per diem basis. The net earnings are obtained by the use of the operating ratio. These earnings are shown under four captions, it being assumed where noted that 11 per cent of the locomotives are always in the shop undergoing repairs, and where switching engines are involved that 90 per cent only are handling freight.

These figures bring out that the net average earning power of a locomotive varies from $30 to $125 per day; while for all the roads of the United States the earning power is $44. The average rate per net ton mile is introduced to show one reason why the value of a locomotive fluctuates—a locomotive capable of earning $75 per day on one road may be able to earn only $40 per day on some other road, and this is further affected by the size of the engine, amount of work for it to do, etc.

The value placed on a locomotive when rented of course varies on different roads, both as to amount and basis of computing. (Invariably running repairs are taken care of by the borrower, and general repairs by the lender.) Some use the size of cylinder, others the weight on drivers or total tractive effort. The general minimum charge is $10 per day, increasing to from $25 to $40 for the modern engine. Two roads base the rental on a fixed charge per 1,000 lb. tractive effort, which is about 50 cents. Five roads based their rental charges on the results obtained by calculating interest and depreciation on the value of the locomotive in question. To this is added charges for general repairs, taxes, insurance and profit on the transaction. An example of this with the profit omitted will show what might be termed "out-of-pocket" value of a locomotive.

The following table shows approximately what this would amount to for different original costs between $10,000 and $30,000

Road	Mileage	Total transportation revenue	Freight revenue	Total number locomotives	Freight engines	Passenger engines	Switch and transfer engines	Gross earnings per day: All freight, 90 per cent, and switch	Gross earnings per day: All freight, 90 per cent, and switch, less 11 per cent †	Gross earnings per day: Freight, less 11 per cent †	Net earnings per day, freight, less 11 per cent	Operating ratio	Average revenue per T.M.—Mills
B	9,129	$93,330,370	$64,063,856	1,772	901	444	427	$121	$136	$194	$64.80	66.59	7.29
C*	2,012	33,597,124	23,181,395	732	347	157	228	115	129	205	43.10	79.04	5.43
D	1,496	13,901,415	9,795,074	293	207	45	41	110	124	146	39.00	73.28	7.32
E	9,710	81,888,321	58,540,091	1,952	1,262	345	345	102	114	143	44.50	68.90	7.88
F	7,976	82,311,523	54,661,588	1,781	1,047	390	344	110	124	161	47.00	70.15	8.70
G	8,240	70,853,004	46,428,045	1,608	775	496	337	118	133	185	48.80	73.57	8.90
H	1,747	16,898,666	10,857,207	376	235	76	65	102	114	142	42.60	69.95	8.60
I	1,032	15,114,030	9,908,251	345	161	89	95	110	124	190	30.00	84.17	5.61
J	1,275	16,111,571	11,987,134	399	263	76	60	103	116	140	27.70	80.19	5.15
K*	2,338	34,790,798	27,549,696	811	413	133	265	116	130	205	62.00	69.69	4.12
L	2,636	24,331,048	18,078,140	617	360	147	110	108	121	155	47.00	69.71	11.93
M	801	13,132,536	12,385,212	264	133	...	131	135	153	286	125.00	56.26	7.05
N	7,750	78,297,710	58,426,236	1,284	799	369	116	177	199	225	93.00	58.27	7.65
O	4,763	63,747,632	42,589,299	1,460	803	357	300	109	122	163	35.90	77.86	5.77
P*	1,872	57,745,398	39,376,127	980	408	212	360	147	165	297	101.00	66.14	5.33
O*	1,819	35,019,744	23,018,013	703	348	141	214	116	131	204	60.40	70.40	6.42
R	3,817	32,104,311	20,912,978	682	404	156	122	112	126	159	46.90	70.51	11.42
S	7,285	61,671,460	45,748,269	1,153	767	230	156	138	155	183	.....	....	.....
T	2,943	20,968,555	15,330,648	313	317	161	51	177	199	227	91.90	59.47	7.05
U	1,092	10,795,233	8,155,027	216									
V	6,684	71,625,298	52,270,686	1,276	736	316	224	152	171	208	80.00	61.47	8.39
W	1,885	17,886,817	12,407,401	392	230	85	77	114	128	166	30.40	81.71	9.69
X	7,569	91,810,307	63,773,804	1,465	877	380	208	164	185	224	101.00	55.08	9.27
Y	2,515	31,486,479	21,774,362	697	422	133	142	109	122	159	35.40	77.73	5.85

* Lines East of Chicago.
† Where noted, 11 per cent of the engines are assured to be in the shop; 90 per cent of switch engines are assured to be engaged in freight service; 10 per cent passenger.

*Abstract of paper presented before the Western Railway Club, February 16, 1915.

with assumed charges for interest, depreciation, taxes, etc., and repairs. In the case of repairs, these are based on the assumption that 100 miles represent a day's work for a locomotive.

RENTAL PER DAY, BASED ON INTEREST, DEPRECIATION, TAXES, INSURANCE AND REPAIRS

Original cost	Interest at 5 per cent	Depreciation at 5 per cent	Taxes and insurance at $1.09 per $100	Repairs, basis 100 miles per day	Total
$10,000	$1.37	$1.37	$0.30	$7.00	$10.04
15,000	2.06	2.06	.45	8.00	12.57
20,000	2.74	2.74	.60	9.00	15.08
25,000	3.43	3.43	.75	10.00	17.61
30,000	4.11	4.11	.90	11.00	20.12

Of the four methods used, namely, size of cylinder, weight of drivers, rate per 1,000 lb. tractive effort and interest and depreciation, the last two are more accurate, and the third is more attractive from the standpoint of simplicity. One must admit, however, that the last discriminates between the modern, highly efficient engine and the old engine which is less efficient. The modern engine with the latest devices to give more economical performance certainly is worth more than the same size engine built ten or even five years ago.

We have thus developed three measures of the value of a locomotive: What it can actually earn; what it is worth from an investment standpoint, or what might be termed the "out-of-pocket" value, and what it is usually rented for. We have also shown that 99 per cent of the total operating revenue is produced by these locomotives while moving trains.

An engine earns money only while it is moving freight, and is unproductive when not working. In order to bring out forcibly the actual miles an engine makes per day, data have been taken from the reports of the Interstate Commerce Commission for 24 roads, which shows an average of 57 miles per day or 4 hours at 14 m. p. h. for freight locomotives. On the road with which I am connected a study has been made of just how a freight locomotive day is spent and a form of report* has been developed under the direction of N. D. Ballentine, assistant to the second vice-president, which accounts for every movement of the locomotive during the day. Reports are made independently by the roundhouse foreman, yardmaster and train conductor and these are combined with the information regarding engines in the shop into a single report which is summarized for the month something as below. (In comparing this data with other lines great care should be taken to know on just what basis their data is prepared, and unless the information is developed from a record to that described above, its accuracy may be open to serious question.)

FREIGHT LOCOMOTIVES—MECHANICAL DEPARTMENT CARE

	Hours	Minutes	
Roundhouse	6	49	28.40 per cent
Running repairs	2	41	11.18 per cent
Classified repairs	3	27	14.38 per cent
Total mechanical department	12	57	53.96 per cent

TERMINAL DETENTION

	Hours	Minutes	
Regular schedule	2	55	
Stock, fruit, vegetables	0	7	
Superior trains	0	3	
Insufficient tonnage	0	20	
Main line obstruction	..	..	
Rest for crews	0	7	
Miscellaneous	0	14	
Time between call and departure	0	16	
Total terminal detention	4	2	16.80 per cent

TIME BETWEEN TERMINALS

	Hours	Minutes	
Actual running time	4	16	17.78 per cent (Miles per day 68)
Meeting trains	0	53	
Station work	1	20	
Track conditions	0	1	
Sixteen hour law	0	1	
Accidents, etc.	0	1	
Block signals	0	2	
Engine failures	0	2	
Car failures	0	3	
Weather conditions	..	..	
Miscellaneous	0	22	
Total time between terminals	7	1	29.24 per cent
Total time accounted for	24	0	100.00 per cent

*See Railway Age Gazette, October 27, 1911, and October 25, 1912, for descriptions of these reports.

This brings out clearly the following points:

	Hours	Minutes	
An engine is in the hands of the mechanical department being made ready to move tonnage	12	57	53.9 per cent
An engine is in the hands of the transportation department ready to move tonnage	6	47	28.3 per cent
An engine is actually moving tonnage and therefore earning money, only	4	16	17.8 per cent

This brings us to the third division of this paper, viz., What can be done to make the engine more available for handling tonnage? This same thought is very aptly stated by George R. Henderson quoted in Baldwin Record of Recent Construction, No. 60. Mr. Henderson stated as follows:

"The author believes in wearing out locomotives as fast as possible. By this he does not mean wearing them out by improper treatment or careless maintenance, but by the legitimate work of hauling trains. The faster they can be worn out the sooner they will be replaced with modern machines, and the strides made in the power and type of locomotives in the last few years have been such that an engine only 10 years old is of comparatively little use, except for branch service."

In the example of the distribution of a locomotive day, the roundhouse is charged with 6 hours and 49 minutes or 28.4 per cent of the day.

This time is taken up in turning the engine. There are several items in connection with this work in the roundhouse which will suggest opportunities to reduce the time. Improved dump grates, good ash pan designs, properly maintained turntables, and hot water boiler washing systems are all vital factors in reducing the time in the roundhouse. Good inspection is necessary in order to save failures on the road. Inspection pits have been found to be advantageous, especially when engines are to be turned quickly and have not time to be placed on the roundhouse pit. There should be enough men in the roundhouse to do the work needed and the facilities should include a small machine shop adjacent to the roundhouse, equipped with drill press, shaper, lathe, bolt cutter and emery wheel, also a small, well-equipped tool room. This machine shop saves a lot of time running back and forth to the big shop. There ought also to be good air and steam pressure.

Running repairs is charged with 2 hours, 41 minutes, or 11.2 per cent of the day. Running repairs no doubt vary closely with the time an engine has been out of shop, and with the thought in mind of reducing the running repairs the road with which I am connected has reduced the mileage between shoppings. There have also been put into effect some changes in detail design, which in many cases eliminate entirely the running repairs. For instance, we cast a brass hub liner on the face of the driving box. The result is that it is unnecessary to drop the wheels between general repairs, and there is saved the cost of this work, which conservatively is $25 for labor and material, and the engine out of service for three days, which at $44 per day is $132. A lesser saving as regards running repairs is made by the use of brass shoe and wedge liners on the driving box. The good effect of these shows most clearly during general repairs. We find them with the tool marks hardly worn out and it is therefore unnecessary to line up the shoe and wedge.

Another source of trouble is the pounding of the main driving boxes with its attendant trouble in the rod brasses. This means the dropping of the wheels to repair the brasses. It would seem that this work could be minimized by the use of some form of removable brass, although we have no experience with these devices; we have, however, used the so-called long driving box with the result that the trouble was entirely eliminated, and in addition there is less wear of the axle. The cost to drop a pair of wheels and to crown the brass is approximately $23 labor and the engine is out of service three days.

To minimize stay bolt trouble the practice of using the same form of flexible stay throughout the breaking zone is a great aid. One of our boiler foremen estimated this alone to save one or two days every 60-day period.

With the advent of the gas and electric welding outfits it has

been possible to make many repairs that heretofore would not have been possible. For instance, we had a Mikado engine with all driving wheels having flat spots 2 to 5 in. long and ⅛ to ¼ in. deep. To have dropped the wheels would have cost not less than $150, which includes the loss in tire material. To this must be added the value of the engine while out of service for three or four days. We welded the flat spots with an electric torch, the wheels being in place under the engine, in five hours at a cost of $2.05 for labor and $5 for material and current. Both the gas and electric torch have been used successfully in this work. This is only a single example of what this device offers in the way of getting an engine into service promptly and at the same time at a greatly reduced cost of repairs. It should be an easy matter on the above showing alone for any railroad to justify the purchase of these outfits. Forty-four dollars saved for an engine day is interest at 5 per cent on $880 per annum, or by saving 20 engines one day you save $880.

After the engine has made its mileage it, of course, gets a general overhauling, and whenever possible we make our engine candidates for shop pull a train to the point of shopping. If it be assumed that an engine receives general repairs every 18 months and that 60 days is the average time from out of service to in service, that means that 11 per cent of the engines are always in the shop. Sixty days multiplied by $44 equals $2,640, the loss while the engine is at the shop. During slack business when locomotives are not needed to move trains, it is obvious that we should put them through the shop to the extent that they are ready for the shop and that the shop can take care of them.

While it is desirable to have a few engines in the "bone yard," so that "lights" and "heavies" can be properly balanced, there can be a saving made by not having too many engines standing around idle waiting to get into the shop, but rather schedule their movement to the shop so that they are available with the least waste of engine time. An ideal condition would be more nearly realized when the condition of the engines slated to go to the shop were such that one or two months in service, if necessary to suit the convenience of the shop, would not mean a series of failures.

When an engine is about to go to the shop, many roads (ours among them) make a practice of sending advance notice to the shop of just what material will be needed. On firebox work 30 days advance notice is desirable, so that the box will be ready to put in as soon as the old box can be cut out. To make the most of this plan of advance notice, the information must be accurate and be acted upon promptly, without waiting to get the engine in the yard to see if the material is *really* needed.

After the engine reaches the shop what improvements can be made there with a view to cutting down the time in the shop? The first thought is modern shop facilities, and, considering that an engine is worth $44 per day, it ought not to be difficult for any one to show substantial savings by the use of more modern shops. Assume a shop turning out 30 engines a month, or 360 per year, and that by making certain changes an engine could be turned out four days sooner. Assume further that for three months of the year there is sufficient business to provide work for these engines just as soon as they are turned out. The saving then will be 90 engines multiplied by four days, or 360 engine days, which at $44 per day equals $15,840. Now, if we had taken this $16,000 and purchased an engine with it, we would have had the same amount of available power, since by changing the shop we saved 360 engine days; but the more modern shop will enable repairs to be made more cheaply, and, further, the capacity of the shop is increased 6.7 per cent. Hence, it would be considerably more economical to modernize the shop. Of course, if this improvement can be made at less than the above the saving is increased proportionately.

Another item which I understand some roads have to contend with is material. An engine is delayed for want of proper repair material, and this delay in some cases runs into months. It must not be understood that this is entirely the fault of the stores department, as many times the material was not ordered as promptly as it might have been. On the other hand, the shop man has a perfect right to assume that certain kinds of material are kept in stock continuously by the stores. A great deal of this material for which engines are delayed is very moderate in price, so that no great valuation is involved, and, further, practically all material is common to several engines, particularly where there are a number of engines in a class, and this reduces the amount of stock necessary to carry in order to adequately protect the engines against delay. Too often the fact seems to be lost sight of that an engine is worth money, and the fact only is seen that there is so much money invested in stock, without regard to whether the equipment can be repaired promptly. This policy cannot be too strongly condemned, since both the mechanical and stores departments are working to the same end, i. e., to keep the engines in condition to earn revenue for the railroad.

DISCUSSION

M. K. Barnum, superintendent of motive power, Baltimore & Ohio, stated that the average number of miles of the locomotive per day and the time in service is surprisingly low, and blamed the conditions under which it is necessary to operate some trains for this low figure. Regarding terminal detention he stated that on the Baltimore & Ohio one division has decreased this delay from three hours to one hour by a careful study, with no cost to the road. One cause of excessive terminal detention is the lack of proper facilities for turning heavy power. These should be provided before such engines are purchased.

H. T. Bentley, superintendent of motive power, Chicago & North Western, stated that enough men should be held in the roundhouse to make running repairs properly when necessary, and not have any more than necessary when engines are not being repaired. He has found it desirable to keep one or two engines in the back shop for comparatively heavy repairs in order to keep men busy all of the time. These repairs will, of course, be more costly but the availability of the men will make it worth while. He did not believe in reducing the mileage between shoppings. His road has kept engines in service by use of special devices on the engines, some such engines having made over 200,000 miles. Engines which a few years ago used to make 4,000 miles per engine failure have made as high as 44,000 miles per failure during the past year. This result is attributed to the special efforts of the roundhouse and shop men together with the use of improved details and special devices on the locomotives.

A. R. Kipp, mechanical superintendent, Soo Line, stated that on regularly assigned engines the mileage is limited by the rest of the engine crews or the 16-hour law. He pointed out that the interest and depreciation of the extra locomotives required for regular crews must be considered together with the claimed decrease in maintenance and productive costs and operating expenses.

N. D. Ballantine, assistant to second vice-president, Rock Island Lines, suggested that the same system as was described in the paper be used on roads maintaining the regular crew system in an endeavor to find out just what the value of a locomotive is under that system.

Mr. Goodwin said that with the value of the freight engine in excess of $44 per day the advantages of regular crewed engines should be carefully studied. It might be found advisable to pool the engines in rush season and assign them when there were plenty of engines available.

Value of Neatness.—We had occasion to go into a shop a short time ago where the virtue of neatness was instilled in a novel manner into the minds of the boys employed. One of the first things a boy is asked and shown how to do is to wrap up parcels. The head of this company believes that if a boy can be trained to properly wrap up objects of awkward shape, one of the cardinal qualities of a useful employee—neatness—is being fostered.—*American Machinist.*

CAR DEPARTMENT

THE STANDARD BOX CAR—A NEGATIVE VIEWPOINT

BY R. W. BURNETT
General Master Car Builder, Canadian Pacific, Montreal, Que.

From time to time we read stirring articles from high railway officers on the desirability of a standard box car; these frequently take the form of a demand, a call to arms to rise and overthrow the mechanical man who, it would seem from these articles, has for many years obstructed progress and caused untold millions of expense by a failure to attain the desired end. Such articles are usually favorably commented on in the railway magazines, the impression seeming to be that the writers must of necessity be right, and the weakness of the mechanical man is sometimes apologized for with suggestions that in time he may come to see the matter in the same broad way as the higher officer.

If the box car situation is analyzed it will be found that the traffic officers and the officers who control the policies of the railroads are responsible for the diversity of box car dimensions, and that no one would be more pleased than the mechanical man if a more limited number of designs were decided on. Cars of varying or unusual dimensions, such as those of more than usual length, height or width of side door, or having large end doors or otherwise fitted for special service or use in a restricted territory; or for service which may be peculiar to the entire territory reached by the home road, are being demanded by the traffic department. It is not for the mechanical man to say that these cars, which may make 90 per cent of their mileage on the home road shall be built to the standard dimensions said by the traffic department to be unsuitable for the home service, in order that the cars may be standard for the 10 per cent of their mileage which may be made on foreign lines.

These matters can only be settled by the traffic department and others who decide on matters of policy affecting almost exclusively their own department. If persons who are at all worried about the box car situation will take the trouble to investigate, they will find that the box cars built in the last few years, especially those with steel superstructure, are costing very little for repairs. Barring wrecks, the repairs are confined almost exclusively to couplers, wheels, trucks and other parts which are all standard. If any large part of these repairs is due to a weakness in the standard the doctrine of adopting a standard box car is then proved unsound, as the standards were usually amply strong to meet the demands of service of the period for which they were designed; if weak, the design has been outgrown in the rapid development of the railways, which is the case with the car itself and which to some extent will be the case with any car that might be adopted at this or any other time.

From the large percentage of steel frame box cars built during the last few years the indications are that this design will be very largely used in the future. These cars are largely constructed of rolled shapes which seldom need renewal, even when a car is wrecked, as they can easily be straightened or reformed to the original shape at any car repair point. It has been found unnecessary to carry rolled shapes in stock for repairs, and as the parts of the cars which fail are the parts which are already standard, it is only necessary to carry in stock lining and decking, which are being standardized. The cars which are giving trouble now, and which are largely causing the uneasiness that brings forth the letters and articles referred to, are the cars which were built from ten to twenty years ago and represent the best state of the art at that time. If the best of them had been adopted as standard and had so continued to the present day, there is no doubt that the present repair bills would be about double what they are, and this to a degree is what it would mean in the way of expense ten or twenty years hence should a standard box car be adopted now.

It is true that we sometimes see appliances on cars, the value of which may be very much questioned, but it is probable that the net result of the use of these questionable devices may be on the credit side of the ledger for the railroads as a whole, as they are for the most part being developed towards some desired end with the final result that a simple and effective device is secured. It is also true that occasionally a designer makes an unfortunate mistake in some vital part of the car which results in bad failures on a certain series of cars, but these cars are usually so thoroughly advertised by the embargo placed on them by other roads that the railroads are benefited as a result, because the same mistake is not likely to be repeated.

If a box car with wooden underframe and superstructure were to be continued it would probably be advisable to go very much more into the standardizing of the parts than has been done, as the wooden car differs from the steel car in that the amount of material carried for repairs increases with the life of the car, whereas the corresponding parts do not have to be carried at all for steel underframe and steel superstructure cars, since more than enough parts are saved from fires and cars demolished in the wrecks to take care of the few renewals that are required. At the Angus shops of the Canadian Pacific, where we have been ordering small lots of 250 box cars at a time to keep the shop going in a small way during the depression, every lot of cars is built slightly different; this in no way affects the desired interchangeability and will reduce the cost of maintenance. These changes are made principally for the following reasons: To protect the lading from the elements; to increase the strength; to reduce the weight, and to reduce the cost of maintenance. Examples are given below of how the conclusions are arrived at governing the changes for the four reasons given above.

Protecting the Lading from the Elements.—We have a sprinkler arranged to test a sufficient number of cars coming out of the shops to determine any possibility of leakage through the roofs, sides and ends. This is not the impractical fire hose test, but is made to approximate the worst storm conditions, and we do not stop when any weakness is found until we find a substantial way of remedying the trouble. This is not usually done by car builders and is obviously much better than waiting for the claims department to report trouble, and the writer considers it unfair for shippers to be forced to use a car designed in all small details by persons who have not had the opportunity to make all of these investigations.

To Increase the Strength.—Minimum weight being a very important factor in the designing and building of cars in the effort to reduce weight, we occasionally turn out a finished design that may require slight strengthening in some of the parts. The necessity of increasing strength is usually confined to the superstructure as we have from experience largely overcome the weaknesses that were common to the underframe.

To Reduce Weight.—While not so necessary as increasing strength, yet it is important to reduce weight where it is possible to do so with safety. Many opportunities are afforded with the variety of rolled shapes that is available, to accomplish this without any additional cost, and often with a reduction in cost.

To Reduce Cost of Maintenance.—While the cost of mainte-

nance is carefully considered by the designer, yet the cars in actual service when carefully observed bring to notice certain items of expense that can be remedied, and in some cases entirely eliminated. The use of rivets in place of bolts is probably one of the most important items to be considered in repair work. Bolts were used in the past for securing parts that would require frequent renewals, but as the failures to these parts have been reduced the bolt, which is expensive in maintenance, has been replaced by the rivet. The use of cast steel and pressed shapes in place of malleable iron have also to be considered here.

The comparatively low average cost of maintenance of the present day, considering the large amount of old wooden equipment still in service, is entirely due to the present design of car which confines the repair expense almost exclusively to the wearing parts, outside of a few unfortunate mistakes in design, as previously mentioned. It must also be borne in mind that the car of the present cannot show the lowest cost of repairs, while relieving the high cost of repairs to the old wooden car which is still with us.

To sum the matter up, the parts that are movable and need to be renewed should be and are standardized. The use of rolled sections gives us a car which is otherwise a car of standard parts. We also have minimum requirements for the center sill construction which would seem, for the reasons given above, to be about as far as we should go at present in standardizing the box car, except that limiting outside and inside dimensions should be arranged for; this should be attended to by the traffic department. One of these dimensions, the height of running boards, it would seem very essential to decide on in order that the roads will not keep on increasing the height of their cars until the government concludes that there is not sufficient room for the trainmen on top of the cars and issues an order that bridges, tunnels and overhead electrical construction must be raised to give sufficient clearance, which would be very expensive.

As small changes in the development of the car do not increase the amount of material to be carried in stock, or the cost of maintenance, why should a complete standard car be adopted, which, if followed, will shut off the improvement of details which is necessary if we are to progress?

PIECE WORK AND ITS ADVANTAGES*

BY E. J. THILL
Piece Work Foreman, New York Central, East Buffalo, N. Y.

The greater part of my railroad career has been spent in connection with piece work, and needless to say, I have had my troubles, due mainly to men who are averse to the use of the system.

I believe we will all have to acknowledge that the tendency of the day work system is to bring the superior workman down to the level of the inferior. This is virtually placing a premium on inefficiency and therefore is opposed to the accomplishment of the desired results. On some of the western railroads there is a system in operation known as the bonus system, whereby a workman receives a bonus in addition to his daily rate of pay. This bonus, I understand, consists of a part of the increase earned by the operator by reason of an increased output, due to increased efficiency and diligence on his part. While this system may give better results and bring better returns to the men than the day work system, it does not seem possible that it will provide maximum output per operator, minimum cost per article, and maximum earning rate per hour, per operator, such as would be attained under a proper piece work system.

There are three potent factors in the successful handling of a piece work system. These are efficient piece work inspectors, peace of mind on the part of the workmen, and a schedule that can be readily understood by the men.

Peace of mind on the part of the workman is absolutely necessary if he is to do his best under any system. This should be considered in the light of the fact that the piece work operator is often suspicious of the piece work inspector. If there is one thing that will put a piece work operator out of sorts, it is the slightest doubt as to whether he has received proper reimbursement for his labor; therefore a great deal depends on the piece work inspector, as the average workman is no mathematician, and generally has an innate suspicion of the inspector, in that he is not reasonably sure that he has received proper returns for the work performed. For this reason the piece work schedule should be one that can be easily interpreted and understood, and combination prices eliminated. The other two factors in an efficient piece work system rest with the management, and make it possible for the success of the one just described.

Extreme care should be exercised by piece work inspectors to see that the men are fully compensated for the work performed, and in the matter of piece work prices, to see that the workman is properly compensated, considering the conditions under which he is working, and that the company obtains the desired results. A piece work price should not be installed where the inspector cannot "back it up." In other words, he should never set a price under given conditions unless he can produce men from the working force who can demonstrate that the price is right and good for an increase of about 50 per cent or more over the day rate. Then, should a workman question the fairness of the price, he can be shown that it is productive of increased earning capacity, and he will readily see that piece work is of great benefit to him and the piece work inspector is his friend. These are the results obtained under a proper piece work system and are conditions that appeal strongly to the operator.

Did you ever stop to consider what little importance you are alone; how little you would amount to if it were not for the association and co-operation of others? What would the tools and machinery of an institution or shop amount to if it were not for the men who operate them? In this sense a piece work inspector should take the operator into his confidence and show him that he believes in him; show him how his earning capacity can be increased and how both he and the railroad company can be benefited, then you will derive from the workman the full benefits resulting from the use of a piece work system.

Every man working in a shop under a proper piece work system knows that it is wise to study at all times ways to get his work out quicker, as he realizes he will be benefited thereby. He is aware that the shop superintendent and his foreman are anxious to co-operate with him along these lines, and that he will not be penalized for using his brains in having the piece work price cut, because by his increased output he is decreasing the cost of production. In my estimation, piece work can never be handled successfully if the management will allow the prices to be cut as soon as they become remunerative to the workmen. Nothing is more discouraging to a man than this price cutting for no other reason than increased efficiency on the part of the operator. Therefore it behooves the piece work inspector when making prices to use the utmost care to note the conditions under which the man is working. In this connection, I wish to bring out that where men are put on piece work, the shop equipment should be of such design and quality as will offer best results and should be kept up at all times.

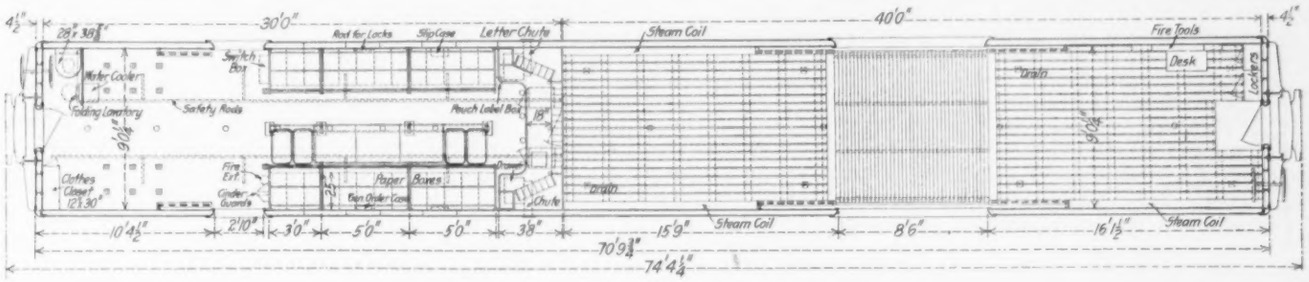
In closing, I desire to emphasize the fact that where a shop is working under a thorough piece work system, there is no question about its efficiency, as I believe piece work may properly be considered a synonym for efficiency.

*From a paper read before the Niagara Frontier Car Men's Association, February 17, 1915.

STEEL BAGGAGE AND MAIL CARS

New Equipment for the Central of New Jersey Is 70 ft. Long and Has a 30 ft. Mail Compartment

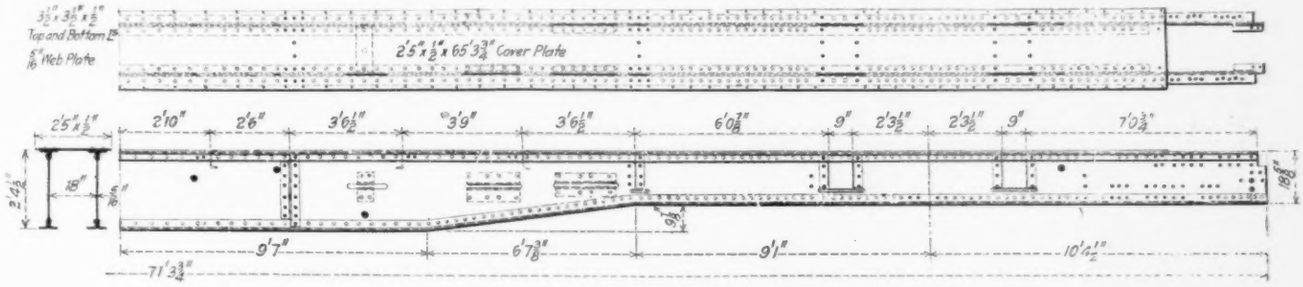
The Central Railroad of New Jersey has in service seven steel baggage and mail cars having a 30 ft. mail compartment equipped according to the United States Government specifications and a 40 ft. compartment for the transportation of baggage or express.



Floor Plan of the Jersey Central Baggage and Mail Cars

These cars were built by the Harlan & Hollingsworth Corporation, Wilmington, Del., are 70 ft. 9¾ in. long over end plates and weigh 144,700 lb. each. They are mounted on six-wheel trucks equipped with the Commonwealth steel frame, and clasp brakes. The web plates are 5/16 in. thick, and each has two 3½ in. by 3½ in. by ½ in. angles riveted to it, top and bottom, while riveted to the flanges of the four top angles is a 2 ft. 5 in. by ½ in. top cover plate. This plate is 65 ft. 3¾ in. long, and does not therefore extend the full length of the car. A bottom cover plate is not used.

The two center crossbearers are placed 5 ft. 4 in. on either side of the center of the car, and are built up of diaphragms



Center Sill Construction of the Baggage and Mail Cars

UNDERFRAMES

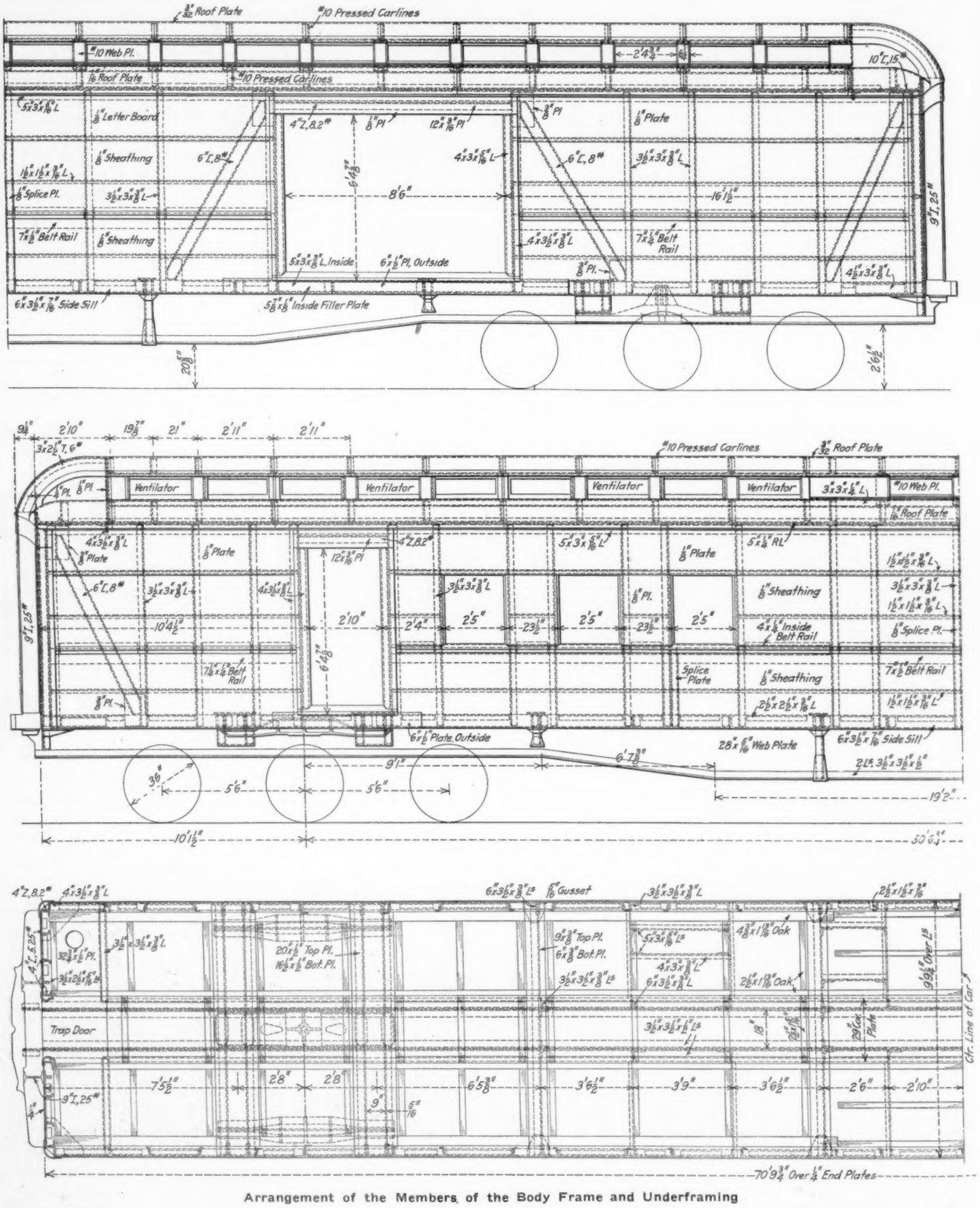
The center girder, which is the main member of the underframe, is of the fishbelly type, built up of steel plates and angles. The two web plates are 2 ft. 4 in. deep at the center of the car, and are spaced 18 in. apart; this depth is maintained for 9 ft. 7 in. on either side of the center of the car, at which point the web plates begin to taper, and at a point 6 ft. 7⅜ in. farther on they reach a depth of 18⅛ in., which is maintained to the end of the car.

Steel Baggage and Mail Car in Service on the Central Railroad of New Jersey

pressed from 5/16 in. plate, which are the full depth of the center sills at the inner end, while the lower flange tapers upward toward the outside of the car till a depth of 6⅛ in. is reached. A 5/16 in. pressed filler is also used between the webs of the center sills, and the crossbearers are finally reinforced by a 6 in. by ⅜ in. cover plate at the bottom and a 9 in. by ⅜ in. cover plate at the top, both extending across the car. The two intermediate crossbearers are spaced 16 ft. 2 in. on either side

of the center of the car and the diaphragms, which are 14 in. deep at the inner end and 6⅛ in. deep at the outer end, are pressed from 5/16 in. plate with a 5/16 in. pressed filler between

The double body bolsters are spaced 50 ft. 6¾ in. between centers and consist of two members whose centers are 2 ft. 8 in. on either side of the center of the center plate. These members

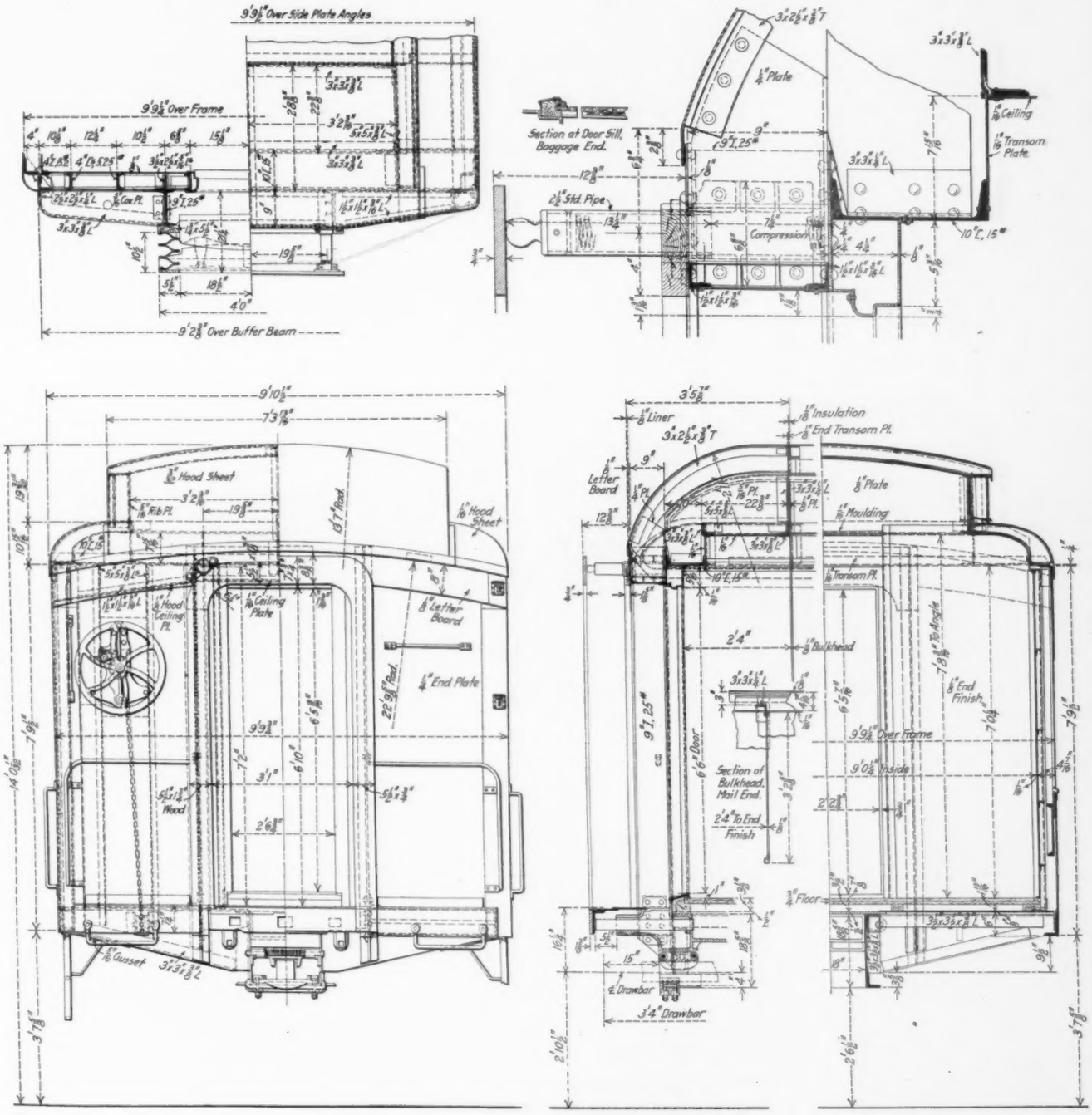


Arrangement of the Members of the Body Frame and Underframing

the webs of the center sills. A top cover plate 9 in. by ⅜ in. is used on the intermediate crossbearers as well as a 6 in. by ⅜ in. bottom cover plate, both extending the width of the car.

are built up of four diaphragms pressed from 5/16 in. plate with 5/16 in. pressed fillers between the webs of the center sills; a 20 in. by ½ in. top cover plate is used and a 16½ in. by ½ in.

bottom cover plate, both extending the width of the car and riveted to the pressed diaphragms and fillers. Steel castings of special section are riveted to the two cross members of the body bolster at points 3 ft. 10 in. on either side of the longitudinal center line of the car and support the body side bearings. Cross ties or floor supports consisting of 6 in., 8 lb. channels are used, and extend between the center and side sills. The side sills are toward the outside of the car and the back 10⅛ in. nearer the center of the car than the inside of the web of the Z-bar, and another channel of the same size and weight is placed 12¼ in. nearer the center of the car with the flanges turned inward. At a distance 10½ in. farther in from the back of the inside channel two 3½ in. by 2½ in. by 5/16 in. angles are placed with the long flanges riveted together and the short flanges turned out-



End Construction of the Steel Baggage and Mail Cars

6 in. by 3½ in. by 7/16 in. angles and extend the full length of the car.

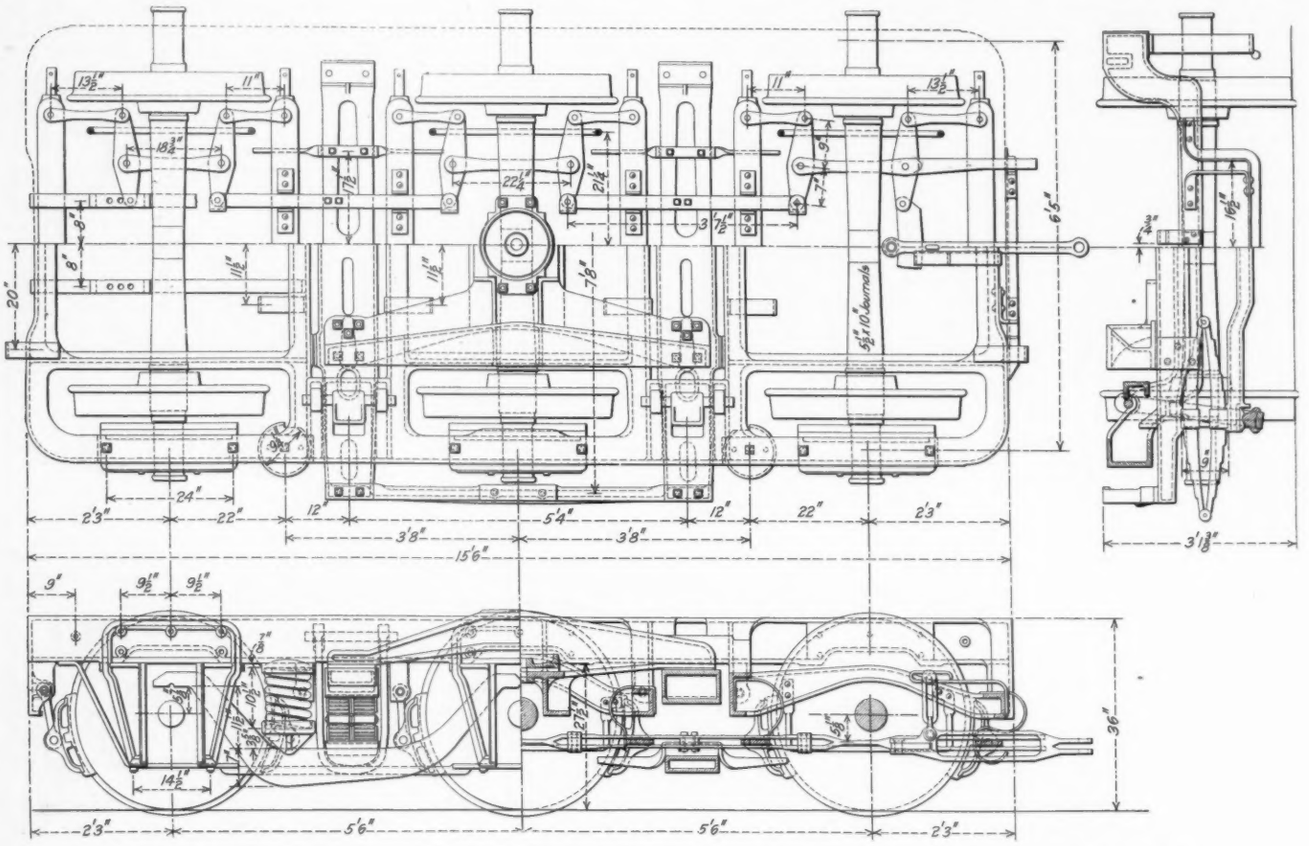
END CONSTRUCTION

The end construction is of the dummy type. The corner post of the car is a 4 in. by 3½ in. by ⅜ in. angle to which is riveted a 4 in., 8.2 lb. Z-bar, and a 2½ in. by 2½ in. by ¼ in. angle is also riveted to this Z-bar as shown in the drawing of the end construction. A 4 in., 5.25 lb. channel is placed with the flanges ward at the end of the car. A 4 in., 5.25 lb. channel with the flanges toward the outside of the car and its back placed 6⅝ in. beyond the center of these two angles forms the door post. The main vertical buffing members are 9 in., 25 lb. I-beams, and are riveted to the two connected angles referred to above. An end buffing sill construction of 3 in. by 3 in. by ⅜ in. angles and 5/16 in. plate extends between this I-beam and the corner of the car. The end members are connected at the top by a 10 in.,

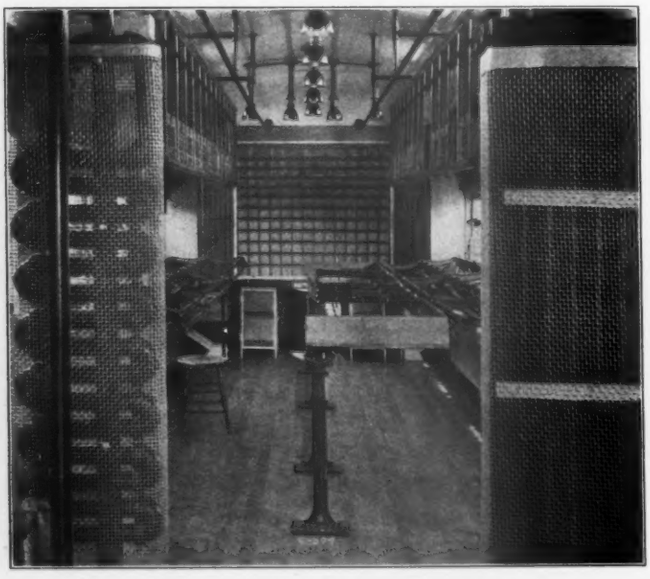
15 lb. channel, extending across the car with the flanges turned upward.

BODY FRAMING

The baggage doors have an opening 8 ft. 6 in. wide by 6 ft. 2⅛ in. in height, while the side doors in the mail end of the car are 2 ft. 10 in. wide and the same height as the side doors in the baggage compartment. There are 6 in., 8 lb. channel diagonal braces used between the top of the corner posts and the bottom of the first side post on either side of the car as well as between the top of the door post and the bottom of the side posts next adjoining. The belt rail is 7 in. by ¼ in. plate from the door posts to the corners of the car and 7 in. by ½ in. plate between the doors; and the side posts are 3½ in. by 3 in. by ⅜ in angles; the side sheathing is ⅛ in. plate. The side door posts are 4 in. by 3 in. by 5/16 in. angles connected at the top by 4 in., 8.2 lb. Z-bars. The side plate is a 5 in. by 3 in. by 5/16 in. angle, to the upper flange of which is riveted a 5 in. by ¼ in. plate with a 2½ in. by 2½ in. by ¼ in. angle above this. The deck sill is a 3 in. by 3 in. by ¼ in. angle, and the carlines are pressed from No. 10 steel plate. The lower deck roof plates are 1/16 in. thick and the upper deck plates are 3/32 in. thick.



Six-Wheel Truck with Commonwealth Cast Steel Frame, Used on the Jersey Central Baggage and Mail Cars



Interior of the Mail Compartment

OTHER DETAILS

The trucks are of the six-wheel type, have clasp brakes and are fitted with the Commonwealth cast steel frame, which is 15 ft. 6 in. long over all. The truck wheel base is 11 ft. and the journals are 5½ in. by 10 in. M. C. B. standard. The wheels are Midvale solid steel and are 36 in. in diameter.

The floor in the mail compartment is of ⅛ in. steel plate with 3-ply Salamander insulation and double wood floors, the bottom floor being ¾ in. yellow pine, while the top floor is ¾ in. maple. 1/16 in. insulating paper being placed between the two layers. In the baggage end the floor is of Flexolith composition laid on Keystone metal with ⅛ in. floor plates and covered with yellow pine grating. There is an oak flooring at the doorway laid crosswise of the car. The inner side of all the outside plates throughout the car is lined with 3-ply Salamander insulation while the outer side of all the inside plates in the mail compartment is insulated with the same material, excepting the ceiling plates, which are insulated by Agasote strips between the plates and the carlines. There is no insulation on the inside finish in the baggage compartment. The mail compartment is sheathed on the inside with 1/16 in. steel plates on the sides and No. 16 gage plates on the upper ceiling. The lower ceiling is covered with No. 20 gage plate while the ends are sheathed with ⅛ in. steel plate. This is also followed in the baggage compartment.

The special equipment includes Gould couplers, centering devices and friction draft gear; Miner friction buffing gear; Ajax vestibule diaphragms; Standard Heat & Ventilation Company's vapor system of heating; Safety Car Heating & Lighting Company's axle light equipment and lighting fixtures; Edison storage batteries; Adams & Westlake Company's folding lavatory; Westinghouse air brake and signal system; American slack adjusters; Ward ventilators and Gould journal boxes.

EXPERIMENTS TO DETERMINE THE STRESSES IN TRUCK SIDE FRAMES*

BY L. E. ENDSLEY
Professor of Railway Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pa.

The design of the different members of a freight car truck has received careful attention for a good many years, but so far as the writer knows, no definite information had ever been obtained with regard to the actual force coming on the side frame until the work herein described was undertaken. The object of these experiments was to obtain the actual force coming on the truck side frame and from the results thus obtained, to check tests on a truck side frame in which certain forces were assumed.

The three main forces to which the side frame is subject are, the downward spring pressure, the end thrust of the bolster, and the twisting of the side frame caused by the spring plank when the car is on a curve and the inside pair of wheels is attempting to get ahead of the outside pair. Of the three forces mentioned, the maximum direct vertical force had often been estimated and was generally considered to be not over twice the normal load on the frame when the car was standing still. That is, the vibration of the car up and down on its springs might carry the pressure underneath the spring from almost nothing to double the normal load.

The car used in the test was a Pennsylvania standard H 21 hopper, which had special cast steel trucks. One truck was designed to obtain the direct vertical load, and the other to obtain the bolster thrust and the twist of the spring plank. Special apparatus was used to determine the forces. After the car was equipped, it was first tested light, by putting it next to a switch engine in the Allegheny yards of the Pennsylvania Railroad. This was done in order that minor adjustments of the apparatus might be made and the entire arrangement tried out. After this the car was put in local and through freight trains and repeated round trips from Pittsburgh to Alliance were made. One round trip was made between Pittsburgh and Altoona in fast freight service to obtain the force due to the twisting action of the spring plank.

Table I gives the results obtained with regard to the maximum direct vertical force on the side frame.

TABLE I.—RESULTS OF TESTS TO DETERMINE MAXIMUM VERTICAL PRESSURE ON TRUCK SIDE FRAME

Test	Kind of service	Load on car, lb.	Load on truck side frame normal, lb.	Maximum pressure on side frame, lb.	Maximum load in per cent of normal
1	Local	None	8,175	16,400	200
2	Local	None	8,175	15,800	193
3	Local	66,000	24,675	52,800	214
4	Local	66,000	24,675	45,000	182
5	Through freight	91,000	30,925	66,600	216
6	Through freight	91,000	30,925	76,000	246
7	Through freight	91,000	30,925	60,000	194

The first three columns are self-explanatory. Column IV gives the load in pounds on the side frame with the car standing still. These values were obtained by subtracting the weight of the wheels, axles, side frames and journal boxes from the total weight of the car, and dividing the remainder by four. Column V gives the maximum pressure obtained with the direct vertical load. This was obtained from the record made of the maximum compressing of the springs. The first four values in this column were obtained while the car was equipped with M. C. B. standard 100,000 lb. capacity springs, each of which has a capacity of 64,000 lb. before going solid, while the last three values were obtained with special springs, each having a capacity of 104,000 lb. before going solid. Column VI gives the total load in per cent of the normal.

Table II gives the results obtained with regard to the maximum pressure set up between the bolster and side frame, due to the end thrust of the bolster against the columns of the frame.

TABLE II.—RESULTS OF TESTS TO DETERMINE MAXIMUM BOLSTER THRUST ON TRUCK SIDE FRAME

Test	Kind of service	Load on car, lb.	Load on truck side frame normal, lb.	Bolster thrust in lb. on side frame, maximum Right	Left	Bolster thrust in per cent of normal load on side frame Right	Left
1	Local	None	8,175	4,300	4,600	52.6	56.2
2	Local	66,000	24,675	5,900	9,200	24.0	37.4
3	Local	119,150	38,463	5,900	9,500	15.4	25.4
4	Local	91,000	30,925	8,500	7,500	27.4	24.2
5	Local	91,000	30,925	5,400	5,300	17.4	17.2
6	Local	91,000	30,925	4,000	5,100	13.0	16.5
7	Through fast freight	91,000	30,925	4,900	7,500	15.8	24.2
8	Through fast freight	91,000	30,925	7,300	7,300	23.6	23.6

Each test represents a round trip, Pittsburgh to Alliance.

Table III gives the results obtained with regard to the maximum force due to the twisting action of the spring plank on the frame.

TABLE III.—RESULT OF TESTS TO DETERMINE MAXIMUM TWISTING FORCE ON TRUCK SIDE FRAME

Test	Kind of service	Load in car, lb.	Load on truck side frame normal, lb.	Twisting of spring plank in lb. at center of truck, maximum	Twisting load in per cent of normal load on side frame
1	Local	None	8,175	3,000	36.7
2	Local	66,000	24,675	3,975	16.1
3	Local	119,150	38,463	4,975	12.8
4	Local	91,000	30,925	5,050	16.3
5	Local	91,000	30,925	5,050	16.3
6	Through fast freight	91,000	30,925	5,550	18.0
7	Through fast freight	91,000	30,925	6,100	19.6

First six tests represent trips from Pittsburgh to Alliance and return. Test 7 represents trip from Pittsburgh to Altoona and return.

From a survey of the results obtained in Table I, it will be seen that the maximum direct vertical pressure may vary from 182 per cent to 246 per cent of the normal load on the frame. The results, however, show that only in one case does the maximum load exceed 216 per cent of the normal load, so that for the design of a freight car truck probably a conservative figure would be 220 per cent of the normal load on the frame. It was found, however, during three round trip tests between Pittsburgh and Alliance, in which the standard M. C. B. springs were employed and the total weight of the car was 139,700 lb., that the springs went solid several times during each trip of 80 miles. This would indicate that a force of over 64,000 lb., which was the capacity of the springs, came upon them.

After it became evident that these springs were going solid, the car was equipped with four new sets, each having a capacity of 104,000 lb., and three round trips were made, the results of which are given as the last three lines in column V of Table I. These results indicate clearly that the standard M. C. B. springs do not have sufficient capacity and that forces of over 70,000 lb. are not unusual with a normal load of 30,925 lb. on the frame. Now if we consider for the average 100,000 lb. capacity car, weighing 40,000 lb., and loaded to 110,000 lb. capacity, making a total weight of 150,000 lb., that the wheels, axles, side frames and journal boxes are not carried by the springs, the normal load carried by each spring would approximate 33,000 lb. If we consider 220 per cent of this load, the maximum force for design would be 72,600 lb. for each frame. This is somewhat higher than most companies have used in their design, 68,500 lb. being a common figure. Then in view of the fact that the springs are going solid, it is almost impossible to predict what maximum force might be obtained due to the impact after the springs go solid. This may account for a great many failures in arch bar and cast steel side frames.

From a study of Table II, it will be seen that the force ob-

*From a paper presented before the Railway Club of Pittsburgh, February 26, 1915.

tained due to the end thrust of the bolster against the columns of the frame, referred to hereafter as the transverse load on the frame, varied considerably, but the maximum with the total weight of the car, 167,850 lb. was 9,500 lb., or 25.4 per cent of the normal load on the side frame. This 25.4 per cent of the average load on a side frame on a 100,000 lb. capacity car would be about 8,500 lb., and probably for safe calculating 9,000 lb. would be the maximum force for test purposes.

From Table III it will be seen that the twisting force reached a maximum in the trip from Pittsburgh to Altoona, and as this force is dependent upon the degree of curvature, this is readily explained, as this track has one or two curves of 8 deg. curvature, and the track between Pittsburgh and Alliance has no curve of over 5 deg. The maximum force obtained was 6,100 lb., from which we may assume that 6,000 lb. would probably be a safe figure for test.

The part of this paper which deals with the actual stress in the side frame, is taken from the results obtained from the tests of some 40 different designs of side frames, using three forces acting on the frame as described above. The exact amounts of the three forces were not the same as those found in actual service, due to the fact that the tests conducted to determine the stress set up in the side frame were made before the tests to determine the actual maximum force were carried out. For the purpose of this paper only the results from two different designs of frame will be considered.

As previously stated, the three forces, namely, direct vertical, transverse and twisting, were found to have maximum values for a 100,000 lb. car of 72,000 lb., 9,000 lb. and 6,000 lb., respectively. The actual forces used in the testing hereafter described were 68,500 lb. direct vertical, 6,000 lb. transverse and 5,000 lb. twisting. However, the results due to the transverse load have been increased 50 per cent and represent the stress due to a transverse load of 9,000 lb. There might be some question in this procedure, if it had not already been found in actual test that for all practical purposes the stress at any point in the frame was directly proportioned to the loads as long as the elastic limit of the metal was not reached.

For the purpose of determining the stress throughout the frame under the three different loads, the Berry strain gage was used. This gage is so constructed that the elongation in 2 in. gage length can be determined to .0002 in.

In preparation for a test the frame was mounted on two heavy supporting castings on the bed plate of the testing machine, this being a 300,000 lb. Riehle machine, located at the Granite City plant of the American Steel Foundries. The distance between the supports was equal to the wheel base of the truck. Double knife edge bearings over the supports were used. Cap castings over the support and filler blocks were also used to obtain the correct height for the spring seat and to support the knife edges. After the frame had been selected for the test, the points of reading were located, and small holes were drilled into the casting about ⅛ in. deep and exactly 2 in. apart, and these holes were then reamed to get a good firm surface for the points of the instruments to rest in.

The two frames to be discussed were from two general types of design, designated according to the cross section of the different members in the frames, namely, the L section and the I section. The L section type is as shown in Fig. 1, and will be referred to as frame A. This design of frame has been discarded by the manufacturers. The I section type, as shown in Fig. 2, is a later type of design and will be referred to as frame B.

RESULTS OF TESTS

When the design of a truck side frame has been discussed the question usually has been, "What factor of safety shall we allow?" An arch bar type side frame has a calculated factor of safety of from 12 to 16. This seemingly large factor was not used originally, but was arrived at by substituting larger and larger sections in an attempt to overcome breakage; yet a great many arch bars break, and we usually say that the metal was not of the correct composition. The same is true of the cast steel side frame; defects are laid to the metal, while they may have been due to the design. In fact it appears that the average designing engineer has been using 25 per cent mechanical knowledge and 75 per cent judgment in the design of the different members that go to make up a freight car truck.

A careful study of the results of these tests will, I believe, bring out some important factors in the design of cast steel side frames.

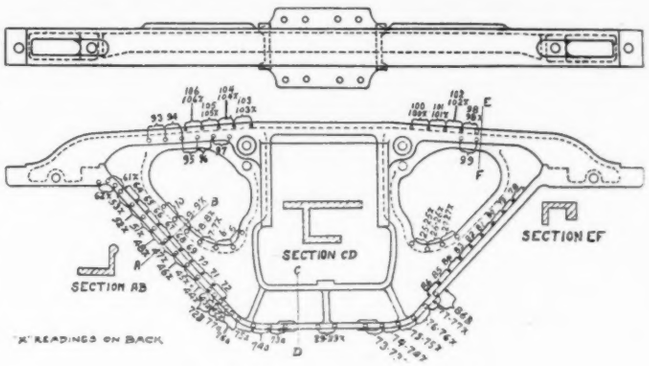


Fig. 1—Truck Frame Design A

The results show clearly that we have not been able to calculate accurately the stresses occurring in the different members of the frame. For instance let us look at the stresses obtained in the tension member of the A frame at readings 46x and 69. Reading 46x is on the web side of the L, and reading 69 was taken on the top of the lower leg of the L at the front or away from the web. The stress at point 46x for the direct vertical load is 1,600 lb. per sq. in. in compression, and at point 69 is 17,600 lb. in tension. Also at the points 8 and 8x, which were taken at the top of the L section, the 8x reading being on the back of the web and the 8 at the front, the 8x reading was 5,400 lb. in tension, and the 8 reading 16,500 lb., showing plainly that the tension member is attempting to bend in such a way

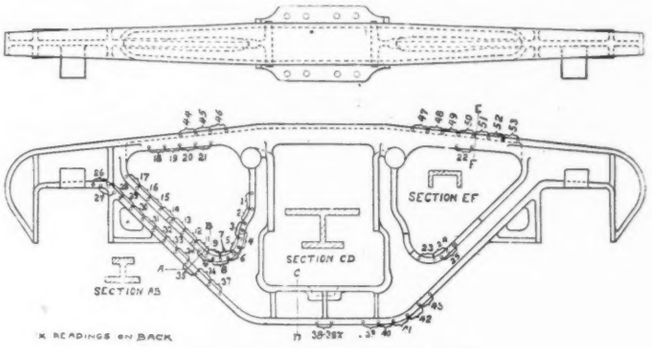


Fig. 2—Truck Frame Design B

that the two legs come nearer to the center of gravity of the member.

Another place where the stress does not follow what might be expected, is at the center and bottom of the frame at readings 29 and 29x. The stress at 29 is 2,700 lbs. compression, and at 29x is 27,000 lb. tension. If we stop to consider a moment we can see why this is true, for the outer edge at point 29 can bend up and relieve itself, thus leaving most of the load for the web side. Now if we look at the results obtained at the same points on the tension member of the B frame where the web is in the center, we find that while there is some variation, it is not so wide. For instance, if we take the reading at the bottom of the B frame at points 38 and 38x, it will be seen that the stress is 14,000 and 12,200 lb. per sq. in., respectively. The average of the two would then be 13,100 lb. Now if we should

average the two stresses at points 29 and 29x on frame A, we would obtain 12,150 lb. in tension, so it will be seen that the average stress for all practical purposes is the same. It is also true that if we should calculate the moment of inertia for the cross section of these two frames at this point, we would find them almost exactly the same.

The same comparison can be made at the lower end of the tension member; that is, the average stress for the direct vertical load on the A frame at points 46x, 69, 8 and 8x, is 9,200 lb., and for the same relative points on the B frame, that is points 34, 34x, 11 and 11x, it is 8,600 lb., which is for all practical purposes the same. For the comparison at the bottom of the frames, the maximum stress on the A frame is 27,000 lb. per sq. in., and 14,000 lb. per sq. in. on the B frame; and at the bottom of the tension member the maximum on the A frame is 17,600 lb. and 11,600 lb. on the B frame. That is, the maximum stress in the B frame under the vertical load is 50 per cent less in the bottom member, due to its symmetry of section, and 30 per cent at the bottom of the tension member in the B frame. This same saving is true in any comparison of the stresses due to the three loads. The maximum indicated stress on the A frame is 38,100 lb., at point 72, and there is a maximum of only 19,400 lb. at point 41x on the B frame.

There are a great many places where the stresses are over 20,000 lb. in the A frame, but none where they are that high in the B frame. In fact there are only 5 points on the B frame where the stress is over 16,000 lb., with the three forces applied, and there are 24 points that show over 16,000 lb. stress on the A frame; there are 7 points on the A frame that show over 25,000 lb. stress. This would indicate that the metal in the A

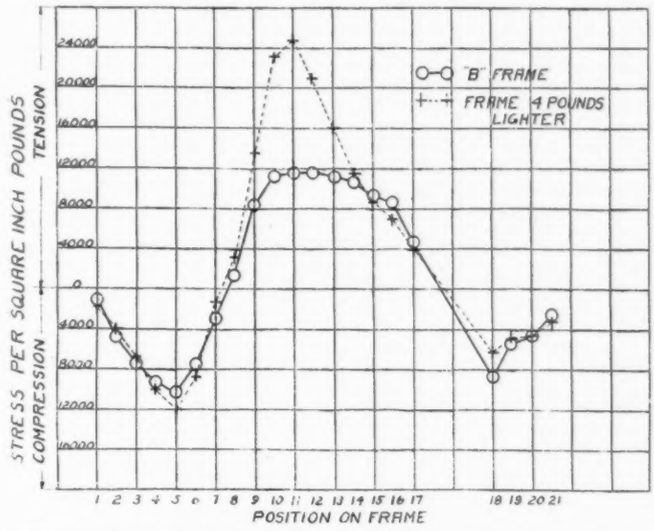


Fig. 3—Comparison of Stresses in Frame B and a Frame Four Pounds Lighter

frame was distributed in such a manner that each pound was doing a more uniform share of the work than is the case in the A frame.

The value of a small amount of metal at the correct point is well shown in Fig. 3. Here are shown two curves, one plotted from the result obtained under the direct vertical load on frame B at the points 1 to 21, inclusive. These values are represented by circles. The other values plotted as crosses on the same ordinates are results obtained from a frame made from the same pattern as frame B, but 4 lb. lighter. This metal was placed as a narrow flange on the B frame, as shown at the top of section A-B Fig. 2. This flange started gradually at point 3 and continued to point 13, where it disappeared into a small bead on each side of the web. The maximum stress at point 11 on the B frame, was only 30 per cent of that obtained on the frame without this flange and which weighed 4 lb. less.

Another place where a small amount of metal can materially reduce the stress is at the bottom flange. The results of tests on four frames of similar design except as to the width of the bottom flange are given in Table IV. The maximum stress indicated was obtained by averaging the stresses at the positions on the different frames represented on the B frame at points 41 and 41x, the weakest points on frame B under all loads.

TABLE IV.—EFFECT OF DIFFERENT WIDTHS OF THE BOTTOM MEMBER ON THE STRESS

Width of bottom member	Maximum average stress in bottom member due to vertical and twisting loads
3½ in.	24,900 lb.
4 in.	20,000 lb.
4½ in.	16,950 lb.
5 in.	13,300 lb.

The transverse load was not taken into consideration because of the fact that it had very little effect at this point, due to its distance from the point of application of the transverse load. The assumption was also made that the twisting force acts in both directions and the stress due to the twisting would at times be positive on both sides of the frame. It will be noted that the maximum average stress will be almost inversely proportioned to the square of the width of the bottom member.

From a survey of the results here given it may be seen that the stress is somewhat higher than might be expected. I am sure we would be very much surprised if we should test an arch bar truck under these methods. It is certain that where we have been assuming that we had a low stress, and that stresses of 8,000 to 10,000 lb. have been breaking frames, we will have to change our assumption and say that it will take over 20,000 lb. to cause cast steel to fail. I feel that cast steel will stand up under occasional stresses up to 20,000 lb. for a good many years.

If we stop to consider the cast steel bolsters we will find that they are getting loads that produce stresses of 20,000 lb., and they are standing up. For instance, a bolster that has a stress of 10,000 lb. under a load of 68,500 lb., which is the load used for calculations by some companies, will often receive double that load as indicated from the tests recorded in the first part of the paper; thus it is seen that 20,000 lb. stress will be produced in the bolster.

The B frame is not heavy; its weight is 435 lb., and as the M. C. B. Association committee last year recommended to the association a frame weighing 500 lb. for 100,000 lb. capacity cars, this frame could be increased 65 lb., and if the metal were well placed, the maximum stress under the three loads would not be above 15,000 lb. at any point. I am confident that if a cast steel frame was never subjected to a stress of over 15,000 lb. the life would be considerably more than the life of the car.

ECONOMIES IN FREIGHT CAR REPAIRS*

BY H. H. HARVEY
General Car Foreman, Chicago, Burlington & Quincy, Chicago, Ill.

One of the most important questions in regard to the freight car repair problem at the present time, is to get rid of the short draft timbers extending only to the body bolster and secured to draft sills by only about four ⅞-in. or 1-in. bolts. Cars thus equipped are not safe to handle in the heavy tonnage trains, and if their owners wish to continue using them, they should keep them on the home rails, regardless of the capacity of the cars. Only recently I saw a box car that had been given heavy general repairs. It had been repainted and made practically new above the sills. It had six 5-in. by 8-in. longitudinal sills, with short draft timbers depending entirely on the vertical bolts with which they were attached to the draft sills for support. Work of this kind is not economical, nor is it safe, and it should be discouraged in every way.

Many economical practices in freight car repairs have been brought out in the past few years, and I would invite your

*From a paper presented at the January meeting of the Western Railway Club.

attention to some that have come to my notice. Few if any of them are original with me, and most of them are in quite general use on various roads, but they may serve to encourage the bringing out of others.

Bolts ⅞ in. and over in diameter can be welded or pieced out to any desired length under a Bradley hammer at a saving of at least $15 per thousand bolts, and they will give satisfactory service.

Old 1⅜-in. truss rods from dismantled cars may be made into brake shafts by upsetting the lower end and truing up the drum under the hammer, and drawing the upper end down to the proper size for the ratchet wheel for a distance of about 4 ft. This makes a good stiff shaft, at a much less cost than when it is made of new iron.

Column bolts for arch bar trucks may be made from old 1⅜-in. body truss rods, by upsetting the two ends about 4 in. or 5 in., truing up under a hammer and leaving the center of the bolt 1⅜ in. in diameter.

Old 1⅜-in. truss rods from dismantled cars may be hammered down under a Bradley hammer into 2 in. by ½ in. flat, 1 in., 1⅛ in., or 1¼ in. round, at a saving from $5 to $12 per ton over new iron. This, of course, does not apply where roads have their own rolling mill.

Coupler pockets that are cracked or broken at the rivet holes may be pieced out at a considerable saving. They also may be made from arch bars from dismantled cars.

Draft springs that have taken a permanent set may be heated, stretched to the proper length and retempered.

The flanges may be sheared from old truck channels, and the web made into plates for strengthening wooden draft sills between the end sill and the body bolster.

Brake shafts from dismantled box and stock cars may be cut off and made into brake shafts for coal and flat cars.

Brake rod jaws from dismantled cars may be cut off and used in making rods for repair work.

Metal brake beams from dismantled cars may be used for repair work on system light-capacity cars, or in changing cars from wood to metal beams.

Very good brake beam hanger supports may be made from old arch bars, which, when riveted to the channel type spring planks, make an economical way to change cars from outside to inside hung brakes.

Many malleable castings may be replaced with forgings or pressings made from scrap at the shops, at a less cost than the price of the malleable castings; carline pockets are a good example of this.

Old wrought iron body bolsters may be made into deadwood plates, carrier irons, tie straps and many other things.

A very good bottom brake shaft support may be made from old arch bar tie straps.

The good part of broken sills, and good sills from dismantled cars may be made into sill splices, at a saving of about $1 per splice.

The bottom two-thirds of short pieces of second hand sills can be used in making running board saddles, grain strips, blind girths, cripple posts, etc.

The lining and the lower course of roof boards from dismantled cars can, if carefully removed, be used for repairs.

The good sheathing on dismantled cars, if carefully removed, may be used below the side and end doors, for making end doors for repair work, and also for sheathing on bunk and company service cars. Old flooring from dismantled cars may be used to good advantage in making grain door nailing strips.

Oak carlines from dismantled cars can be made into first-class outside cross braces for side doors.

Good second-hand brasses may be rebored and relined at a considerable saving; if filled brasses are used it is often only necessary to rebore them.

Second-hand nuts, if promptly picked up from around the repair tracks, can usually be reclaimed by simply giving them an oil bath. It pays to remove nuts from broken stub ends of bolts by hand.

Cracks in the floors of box cars can be calked with oakum and much flooring saved. By using flooring not exceeding 6 in. in width in box cars, the necessity of renewing on account of shrinkage cracks that cause leakage of small grain, will be materially lessened.

Use plates at least 3 in. square under the vertical rod heads at the side plate, also under the heads of bolts going through the sills, to prevent them from pulling down into the plate and sills. This applies to cars with wooden sills and plates.

The ends of old box cars may be greatly strengthened by applying 1¾-in. end lining, extending from corner post to corner post. Many grain leaks may be avoided by fitting this lining tight at the floor and at the girth.

The road with which I am connected has found it good practice to build, at its own shops, from 500 to 700 stock cars a year, in order to use up the good material taken from dismantled cars, which would otherwise have been sold as scrap. These are 36-ft. cars with steel center sills and treated intermediate and side sills. In practically all cases we have been able to use second-hand material in their construction, with the exception of the lumber, steel sills, post pockets, brasses, bolts, etc. This second-hand material is carefully inspected, worked over and the worn parts removed, so that the cars are just as good as if all new material had been used in their construction.

DISCUSSION

J. A. Carney, Chicago, Burlington & Quincy, spoke of the success attained in building up worn collars on car axles by the oxy-acetylene process at a net saving of $2 per axle. He also stated that the practice of tearing down old box cars had proved more economical than burning them; some lumber can be reclaimed, the scrap wood can be used for firing up engines, and the iron will be in much better condition to classify. William Queenan,* also of the Burlington, stated that the cars are torn down on a piece-work basis and that the lumber reclaimed more than pays for the cost of tearing the cars down, reclaiming the lumber and sorting the scrap. In a period of 11 months about 700 cars were torn down, from which $15,000 worth of lumber was reclaimed, the lumber being rated at $14 per 1,000 ft. The cost for doing this work was between $11,000 and $12,000, which leaves a very good margin of profit.

E. G. Chenoweth, Rock Island Lines, took exception to some of the items mentioned in the paper, stating that he believed if everything be considered, that the cost of reclaiming would be more than the purchase of new material, mentioning as one of the items to be considered the freight revenue derived from hauling the material. He called attention to the practice of one road, which uses old 100,000 lb. capacity axles for making axles for 80,000 lb. capacity cars, and old 80,000 lb. capacity axles for making axles for 60,000 lb. capacity cars, the axles being upset and re-turned.

J. F. DeVoy, Chicago, Milwaukee & St. Paul, spoke of the benefits derived from the use of rolling mills for re-rolling the scrap iron. He said that while in every case they would not prove economical on a cost basis, they were of great convenience in cases of emergency. He also mentioned the benefits to be derived from oxy-acetylene welding.

Other members spoke of the possibility of using scrap lumber for making sheds and buildings, and cases were mentioned where the metal roofs from torn-down cars were cut up and used as shingles. The Louisville & Nashville cuts off the flanges of the old metal roofs and reflanges them, using them over again for car roofs.

*Mr. Queenan described the method of making stock cars from scrapped box cars in an article published in the *Railway Age Gazette, Mechanical Edition*, July, 1913, page 379.

SHOP PRACTICE

CLIPS FOR SECURING DATE TAGS TO STEAM GAGES AND SAFETY VALVES

BY C. L. DICKERT
Assistant Master Mechanic, Central of Georgia, Macon, Ga.

The accompanying drawings show a method of securing date tags to steam gages and safety valves and the special tools which have been developed to punch and form the

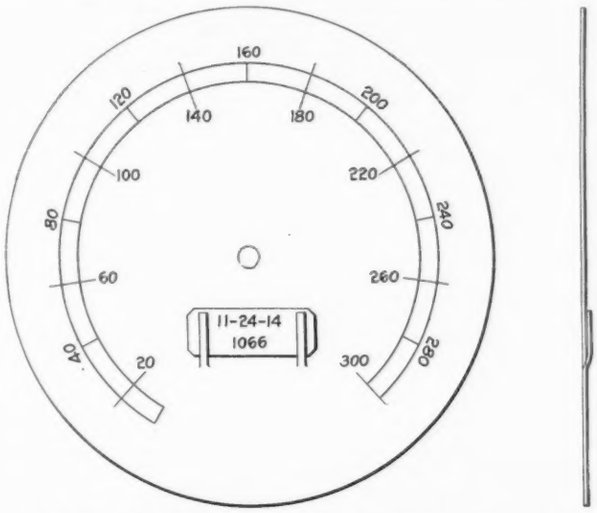


Fig. 1—Method of Applying Date Tags to Gage Dials

clips. Fig. 1 shows a steam gage dial in which the clips have been punched and a date tag inserted. The tags are made of stiff white paper on which the date of test and the

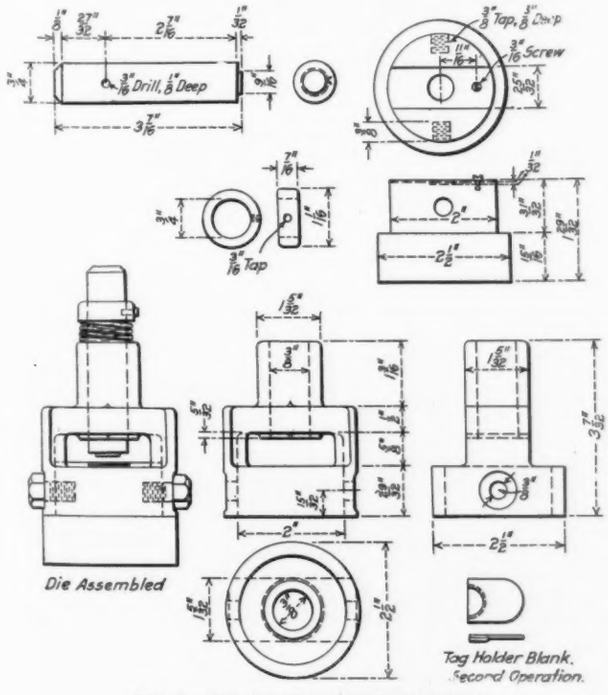


Fig. 2—Dies for Forming Tag Holders

engine number are written with ink. These tags are applied when quarterly inspection is made or for any reason the steam gages are removed and tested. All air gages as well as steam gages are tested at quarterly inspections and tags are applied to them in the same manner. The tool used

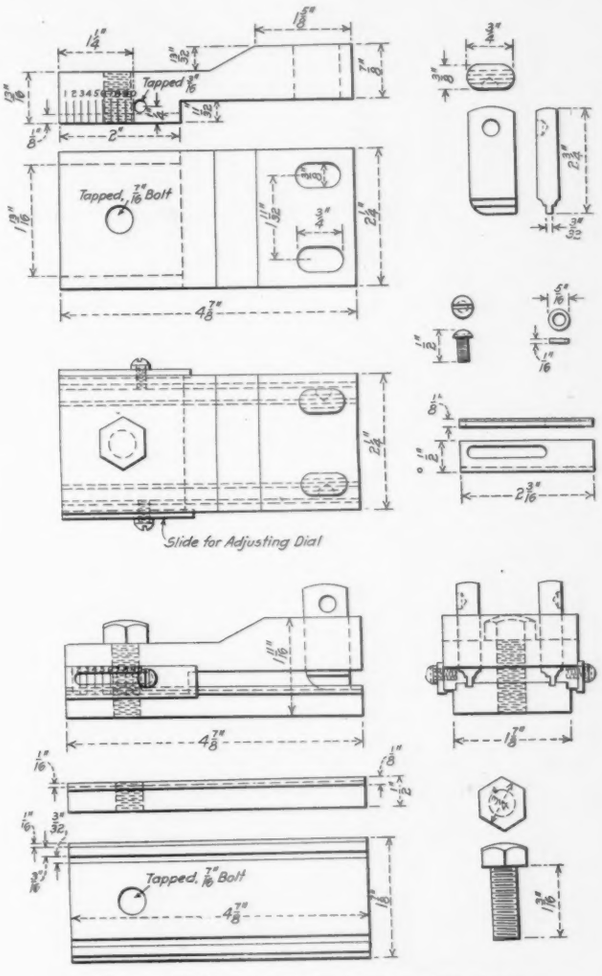


Fig. 3.—Tool for Punching Clips in Gage Dials

for punching clips in the gage dial is shown in Fig. 3. It consists of a die plate and a guide for the punches, held together by means of a 7/16 in. cap screw. The upper piece is lipped over the edges of the die plate to secure proper alinement. Graduated slides are secured to the side of the

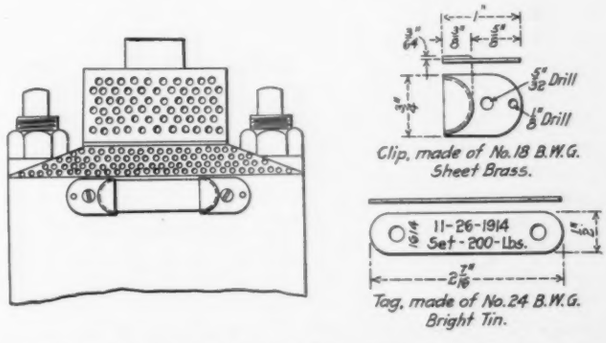


Fig. 4—Method of Securing Date Tags to Safety Valves

device, by means of which the gage dial may be adjusted to secure the proper location of the clips.

The method of securing tags to the safety valve, together with details of the tags and clips, are shown in Fig. 4. The tags are made of bright tin on which are stenciled the engine number, the date tested and the pressure at which the valve is set. A tag may readily be slipped into the clips and after once in place there is no danger of its losing out. When the safety valve is next tested the tag may be pried out with a screw driver and another one inserted. Blue print instructions, showing the method of application and removal, are sent to all outlying points where quarterly inspections are made.

Special tools are provided for cutting and forming the clips. The blanks are punched by the tool shown in Fig. 5. Its body is made up of two parts, the upper part forming a guide for the punch and the lower part containing the die. The punch is fitted into a sleeve within which it is secured from turning by means of a flat dowel, and a stem is screwed into the sleeve against the top of the punch. The sleeve is prevented from turning in the body of the punch by means of a special screw, the end of which slides in a vertical groove in the side of the sleeve. A difference of 1/8 in. is allowed between the diameters of the die and its pocket in the body to provide for accurate alinement. The die is secured in position by means of three set screws, which also hold the two parts of the body together.

After the blanks have been punched, the pockets for the ends of the tags are formed by the tool shown in Fig. 2. This tool consists of a die with a circular depression at the center 1/32 in. deep and a forming tool on the face of which is a corresponding extension 9/16 in. in diameter. By placing the blank in the slot shown in the face of the die with the straight edge on the center line, the tag holder is formed by a blow of a hammer on the stem of the forming tool.

The clips are secured to the safety valve cage by means of one screw and one rivet in each. The holes in the cage are drilled by the use of a jig.

POINTS FOR APPRENTICES TO PONDER

BY H. L. LOUCKS
Machine Shop Foreman, Erie Railroad, Dunmore, Pa.

Keep clean. Keep neat; then watch the results in the improvement of your workmanship.

Don't keep your eye on the other fellow for in the meantime your own work is being neglected; at the same time don't let the other fellow "get something over on you."

Take good care of your tools. A competent machine shop foreman, by an inspection of your outfit, can tell pretty well what class of work you will do.

Make every move count. This life is the greatest game you will ever play in, and don't forget that there are some good places vacant.

Systematize your methods of working.

Be cheerful. Don't watch the clock; as long as you do the hands move the wrong way.

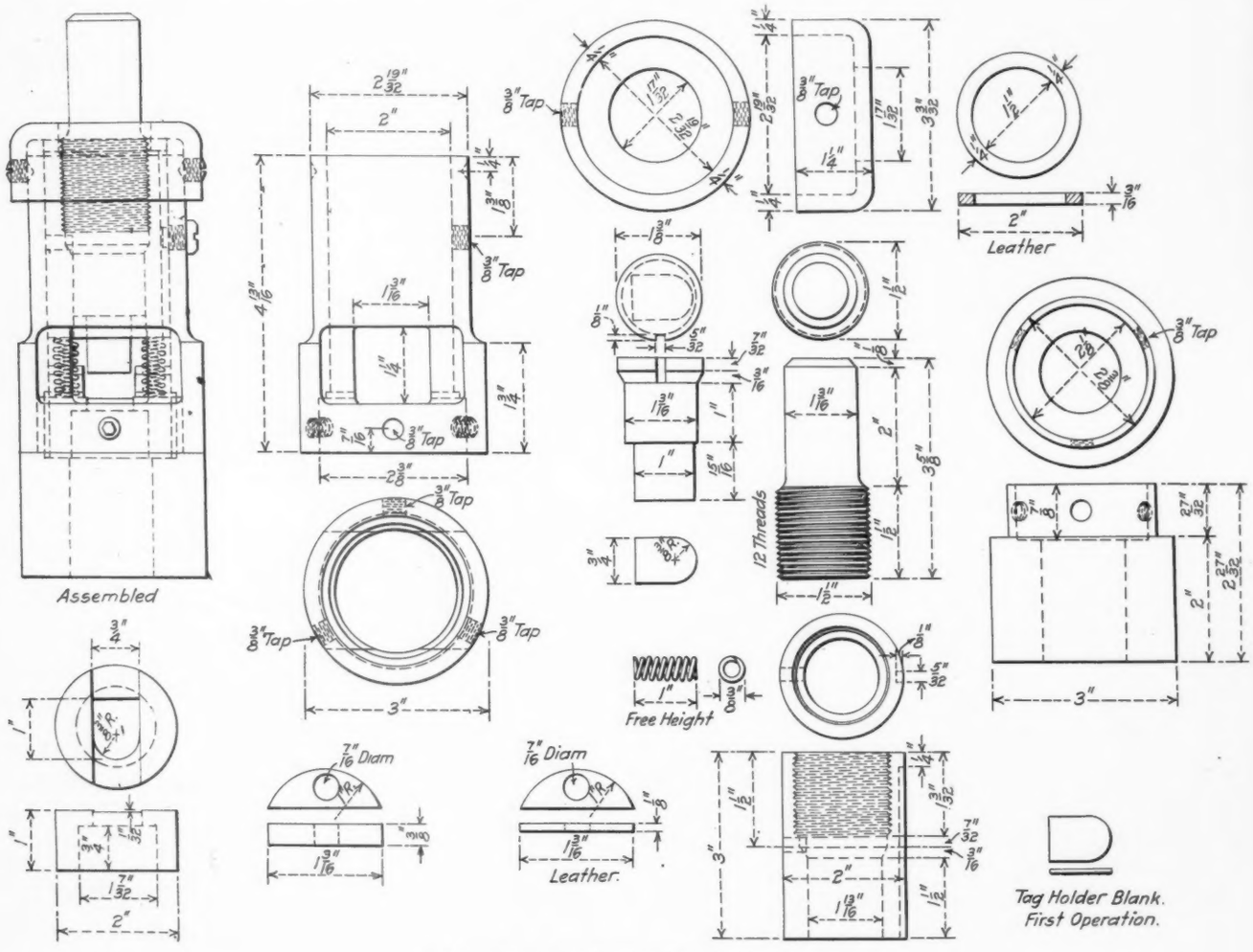


Fig. 5—Punch for Cutting Tag Holder Blanks

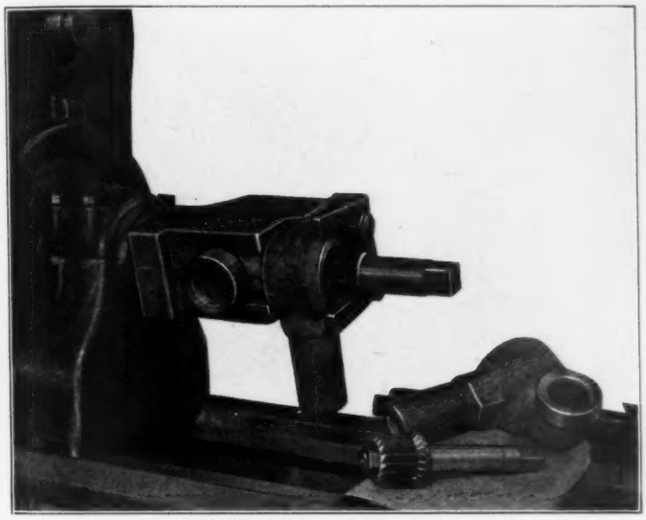
Don't watch the foreman. He is watching *you*.

Don't destroy your employer's property. Remember it belongs to the firm from which you get your living.

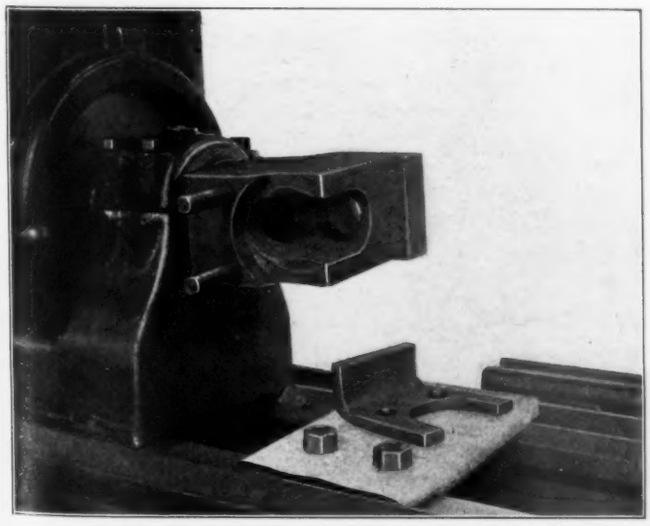
CHUCK FOR FINISHING BOILER CHECK BODIES

BY W. W. ELFE
Machine Foreman, Central of Georgia, Macon, Ga.

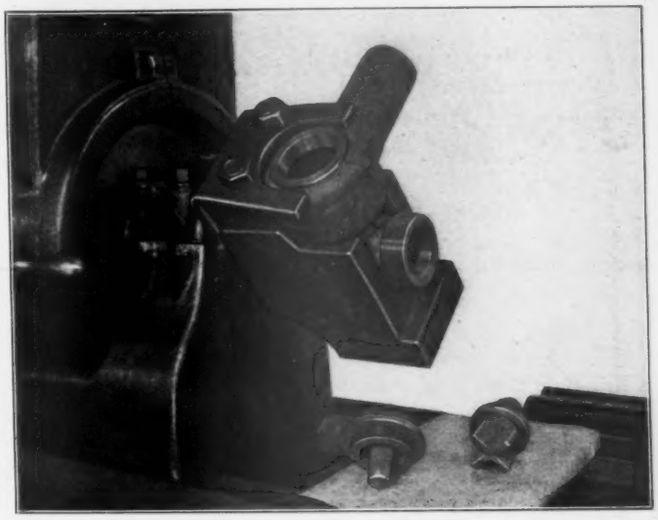
The illustrations show a chuck for finishing boiler check bodies from which good results are being obtained in service. It consists of a cast iron block cored to receive the boiler check body, which is firmly held in position by means of a wrought iron clamp and two studs in one end of the casting. Two sides of the chuck at right angles to each other are bored and threaded to fit the lathe spindle. These are opposite the branch pipe connection and check valve seat of the boiler check. When secured in the chuck it is possible to completely finish a boiler check body with the exception of the boiler connection without resetting the work. The check valve seat is finished by means of a special reamer shown in one of the illustrations and the threads for the cap are tapped on the lathe. The construction of the chuck requires a slightly bent turning tool for finishing the branch pipe connection and the threads are chased by means of a special threading tool. The end of the connection is finished by means of a ball reamer. The boiler connection is finished when the check is applied to the boiler. This work is done on centers, a pipe center being used in the tailstock.



Finishing the Valve Seat and Threading for the Cap



Chuck for Finishing Boiler Check Bodies



Chuck in Position for Finishing the Branch Pipe Connection

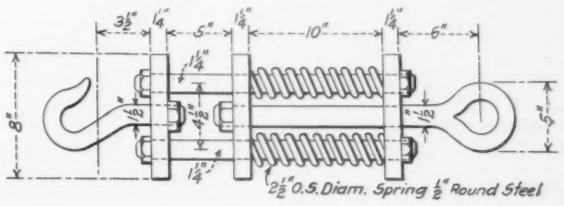
SHOP NOTES FROM THE SOO LINE

BY B. N. LEWIS

The devices described below are in use at the Minneapolis shops of the Minneapolis, St. Paul & Sault Ste. Marie and have been found to be especially convenient on the work for which they were designed.

LIFTING HOOKS

One of the illustrations is a sketch of a lifting hook used for removing heavy work from lathes and other machines in which the work is held on centers. It is of special advantage where a positive lift is made, such as with electric crane service. Its construction is clearly shown in the illustration, and by its use the danger of bending the centers or pulling the work out of the machine before the centers have been released is practically eliminated. The compression of the springs will indicate when sufficient force has been applied to suspend the load.

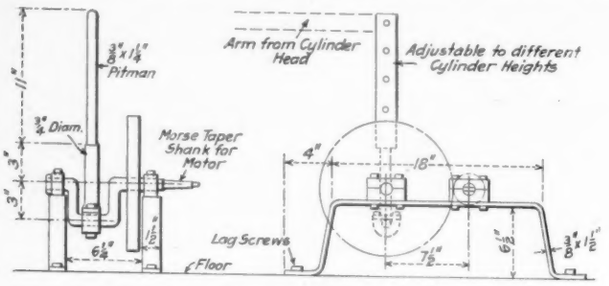


Lifting Hook for Heavy Work

ATTACHMENT FOR GRINDING CYLINDER HEADS

An arrangement for giving the oscillating motion to a cylinder head when it is being ground to the face of the cylinder is shown in another of the engravings. The arm from the cylinder head is attached to the pitman, which is driven by means of an air motor through the gears, as shown in the illustration. The frame work for the machine is made of 1½ in. by ⅜ in. bar iron and is attached to the floor of the shop by lag screws. The cylinder arm and the pitman are provided

with a series of holes to permit adjustment. With this device the work requires the services of only one man, and it may be

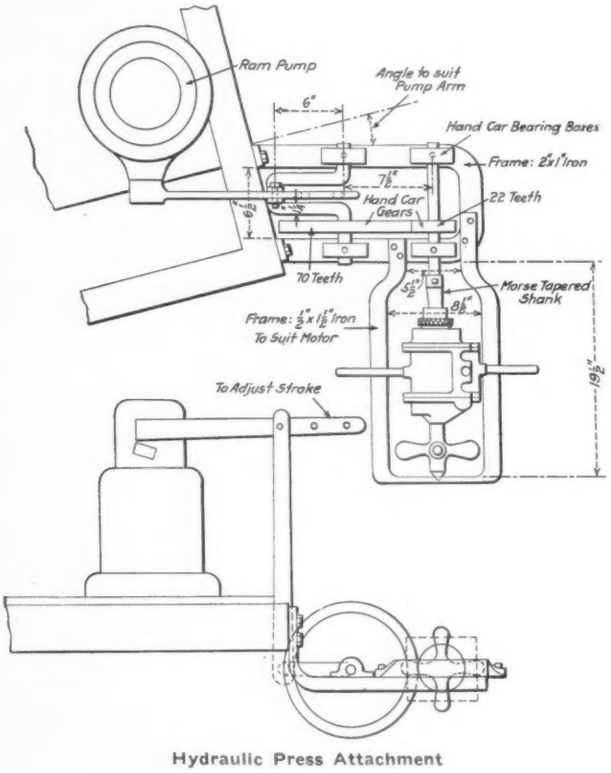


Attachment for Grinding Cylinder Heads

done in a shorter period of time with very satisfactory results.

PORTABLE HYDRAULIC PRESS ATTACHMENT

A device similar in nature to that referred to for grinding cylinder heads and used for operating the pump handle of a hydraulic press is also illustrated. It is made up of a train of gears taken from an old hand car, a crank axle and a driving shaft to receive an air motor. The frame holding these parts is bolted to the base of the hydraulic press as indicated



Hydraulic Press Attachment

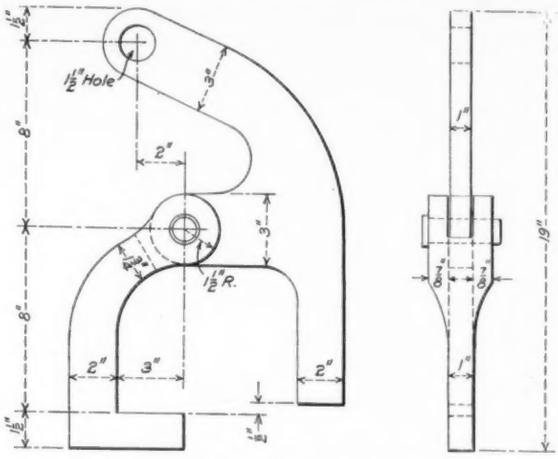
in the illustration. The stroke of the pump is adjustable. This device has been satisfactorily used for operating the press when removing and applying crank pins or driving axles. It saves the time of the men in doing the work, and in some instances it will eliminate the necessity of having more than one man on the job.

TIRE LIFTING HOOK

One of the drawings shows a lifting hook used for tires when they are being set or removed. The clamp is easily applied and eliminates the necessity of using set screw clamps which take time to apply, and which often stick when they become heated. Several sets of screw clamps are also required to accommodate the different widths of tires, but this device will take care of all sizes of tires.

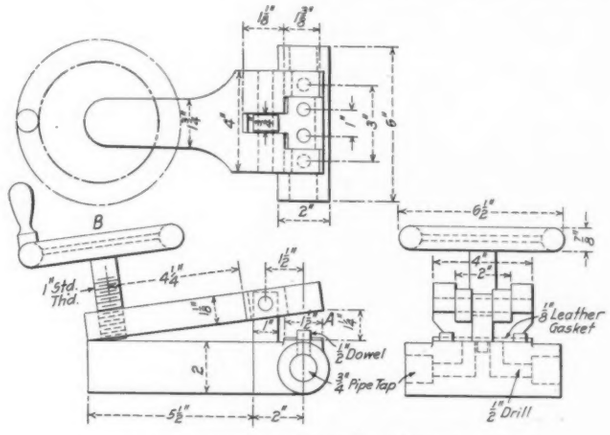
FEED VALVE TESTING CLAMP

Another device in successful use in these shops is a quick-acting clamp to be used when testing air brake feed valves. The valve is placed in the clamp at *A*, shown in the engraving,



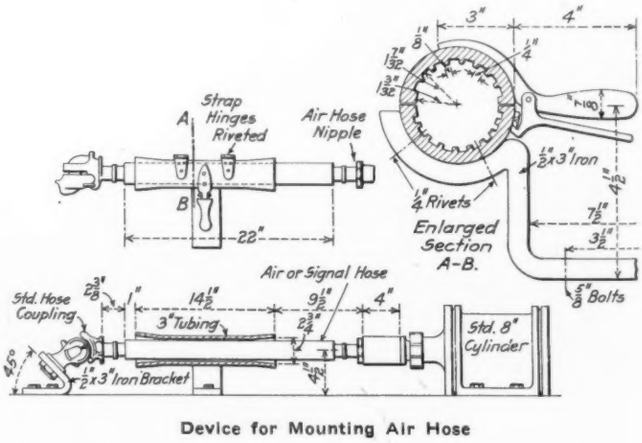
Lifting Hook for Tire Setting

½ in. dowels being applied to fit in the bolt holes of the feed valve. By screwing down on the clamp wheel *B*, the feed valve is securely clamped to a leather gasket as shown, while the air



Clamp for Testing Feed and Reducing Valves

pressure is admitted to the brackets of the clamp and thence to the valve in the same manner as on a locomotive.



Device for Mounting Air Hose

MOUNTING AIR HOSE

Another illustration shows an arrangement that has proved satisfactory in mounting air or signal hose in one operation. A

piece of steel tubing 14½ in. long, fluted as indicated, is held in a clamp attached to the work bench between an air cylinder and an air hose coupling. The nipple is placed on the end of the air cylinder plunger, and as the air pressure is applied both the coupling and the nipple are forced into the hose. The steel tubing is fluted in order to reduce the friction between it and the hose. All material used in the construction of this device is taken from stock usually found in a railroad shop.

ENGINE HOUSE ORGANIZATION*

BY W. P. HUNTLEY
General Foreman, Chesapeake & Ohio, Ashland, Ky.

The accompanying chart shows a system of organization which is applicable to large or small engine houses by adding to or reducing the forces under the different headings.

The important part in roundhouse work is to keep the power moving, but in doing so to know that the engines sent out are in condition to make the trip successfully, with minimum risk of tying up the road by an engine failure. To accomplish this successfully, there must be system. A roundhouse cannot be run successfully unless there is system in the work. The number of men employed should be determined by the number of engines despatched. A machine shop is a necessary addition to a roundhouse terminal at divisional points, but not where an erecting shop is located, as the latter can be depended on to take care of the roundhouse requirements. Neither is the machine shop foreman always necessary; the size of the terminal governs this. Usually the gang foreman will handle the machine men. With first-class facilities, a plan can readily be worked out, but with most railroads feeling the effects of legislative agitation, conditions must be taken as they are, or as they develop, which means the facilities are usually considerably behind the demands and systematic methods are necessary to accomplish the desired results. A roundhouse man should never say "Can't." The word should really be taken out of the English language so far as he is concerned, and the word "try" substituted.

Men with fixed occupations should be directly under the roundhouse foreman, as shown by the chart. The boilermaker foreman and gang foreman are placed in immediate touch with the men in their departments; this enables them to know each job and its progress. These men are required to keep accurate detailed records of the work done by the men in their departments, in an 8 in. by 12 in. record book, indexed with the engine numbers, there being several pages to an engine. The work and the name of the workman is entered therein daily. This is a very useful book in lawsuits, as it contains facts and prevents guess work.

An engine inspector and a good inspection pit are two of the most important factors in engine house organization. If there is no inspection pit, a pit of some kind should be made. At this point, engine crews are relieved in the yards, one mile from the roundhouse and shops. The engines are handled by hostlers to and from the yards. The hostlers keep what is known as a roundhouse record book of the engines they handle. They enter the train number, the engine number, the names of the engine crew, the time the engine arrives on the inspection pit and the time the engine is ready for service. They also keep in this book a record of any delays encountered, to and from the yards. This book is checked by the engine despatcher or clerk with the engine house record book, when he makes his daily report of engines despatched. When an engine comes in from a trip, it is handled to, and left by the hostler on the inspection pit; the hostler delivers the engineman's work report to the engine inspector, who makes his inspection, entering the result on a regular work report over his own signature. He attaches the engineman's report to the one he makes and delivers them to the roundhouse foreman, who figures on the engine from the work shown. The engine watchmen handle the engine from the inspection pit to the ash pit, to the coaling station for coal and sand and over the turntable into the roundhouse. In the meantime, the two work reports are in the hands of the gang and boiler foremen, slips are made for the different jobs and they

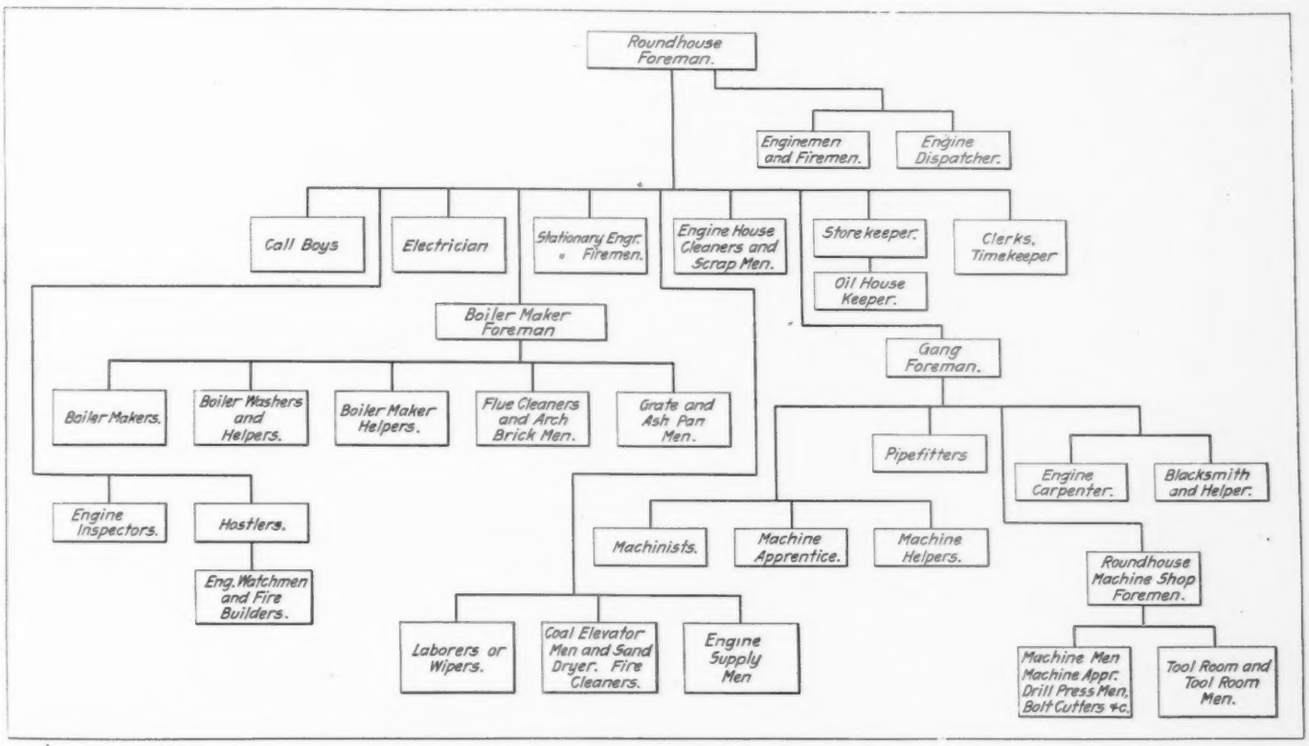


Chart for Engine House Organization

*Entered in the competition on Engine House Work, which closed July 15, 1914.

are ready for the engine when it is placed in the roundhouse. These slips are given to the men and are returned when the job is completed. The name of the man is entered on the slip with the length of time taken on the job. These slips, with the work reports of the engine inspector written up and signed, are filed in book form. As the books are filled they are filed in the foreman's office. This arrangement avoids the necessity of the workman reading the full report, and saves time as the job is specialized and the undivided attention of the workman given to it.

One of the most difficult problems of the roundhouse foreman is keeping in touch with the enginemen and firemen, to avoid a surplus of men in the pool or extra lists. The whereabouts of each man should be carefully kept, that is, those off on leave or from other causes. The call boys or engine callers should make day and night lists of the trains run and the men used, and these lists should be used daily by the clerk and engine despatcher when revising the lists and blackboards, the revised lists being furnished the callers and roundhouse foreman daily. The condition of the work on engines should be transferred by memorandum by the day and night roundhouse foremen daily.

Not every back shop mechanic will make a good roundhouse man; I have reached the conclusion that this will also apply to helpers and laborers. On the other hand, there are comparatively few roundhouse mechanics, helpers or laborers who will not make good in the back shop. This is due to the back shop work being done more mechanically, the roundhouse work requiring more resourcefulness. Invariably in employing a mechanic I ask him about his roundhouse and back shop experience and I find the man that has served a part of his apprenticeship on roundhouse work, does better, quicker work, than the man from the back shop who, as a journeyman, has worked in the roundhouse. I believe that machinist and boilermaker apprentices should be given roundhouse experience during the last half of their third year to develop the confidence requisite in a good roundhouse man and to provide men for this service in the future. It is becoming more difficult to get satisfactory common labor for roundhouse purposes. This class of men prefer back or erecting shop conditions or the work in other industries; invariably the latter pay higher wages, which attract the better element. The roundhouse man necessarily accepts the conditions as presented and must improve them if he can. A record book of applicants who appear eligible, with name, residence, reference and the result of an investigation of the references entered therein will prove of service.

Monthly statements should be compiled showing the detail cost of all classes of labor and roundhouse material; not engine material or supplies that are charged to the different accounts but material used to run the roundhouse and shop, on a basis of the kind and number of engines despatched. The statement, covering all roundhouses, should be furnished to each roundhouse foreman with a direct letter to each man, calling attention to any particular item in the comparison that fits his individual case; comparisons make ambitious men think.

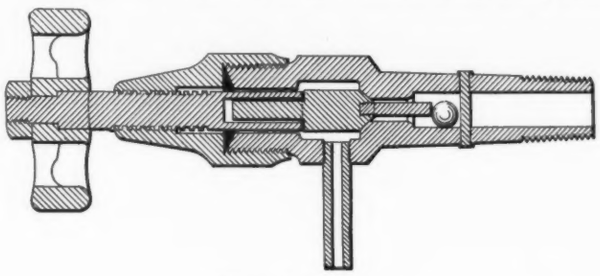
Foremen should endeavor to instill confidence and faith in the men. It is a good asset and they will respond more quickly than might be expected. It seems to me that the secret of success in organization is in knowing just how far you can place responsibility on your men, from the highest to the lowest in the ranks. When you have decided this, build up on it and you will create an organization that will be strong as a whole and will produce results.

ANTHRACITE COAL.—Shipments of anthracite coal are reported for the calendar year 1914 as amounting to 68,302,961 tons, which is 766,667 tons less than in 1913. The total output, including an estimated 3 per cent sold to local trade and to employees, was over seventy millions, and in addition to this an estimated quantity of eight millions was used in operating the mines.

WATER GAGE COCKS

BY PAUL R. DUFFEY

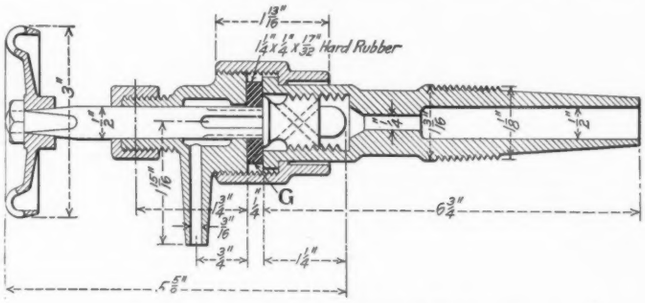
A new style of locomotive water gage cock, which is the invention of Harry Glenns, Portsmouth, Ohio, is shown in one of the illustrations. In designing this cock it was desired to obtain one that would meet the rigid requirements of the Interstate Commerce Commission and permit the user easy access in making repairs while the locomotive is under steam. It will be seen that the device is made in such a manner that the valve may be easily removed and replaced in case of necessity. To do this the stem and cap are first removed, when the valve may be taken from the body, the passage from the boiler being closed



Glenn Gage Cock

by the ball valve. In regrinding while the boiler is under pressure, the tail piece, which holds the ball valve from its seat, is removed. The valve is then reground on its seat by means of a special socket made for that purpose. The ball valve prevents the escape of steam from the boiler during this operation. If the gage cock is used frequently no trouble is experienced from the ball valve becoming covered with scale.

Another simple design of water gage cock is also illustrated. It is simple in construction as well as efficient from a service point and meets the requirements of the Interstate Commerce Commission. The possibilities of leaks are much less than in many of the types now in use. The valve consists of the handle, the spindle, the packing nut, the removable section of the body,



Water Gage Cock with Special Features

the drip tube, which may be cast integral or made separately, as desired, the connecting sleeve, the body and the gasket *G*. The cock when in the position shown does not permit the passage of steam to the section beyond the gasket *G*, and when the spindle is screwed down on the seat in the body it is again closed. To repack the nut, the cock may be either as shown or closed against the seat in the body. To renew the gasket *G*, the cock is closed tight. When in the closed position all parts except the spindle and body may be removed and cleaned or renewed as occasion may demand. Any lime in the outlets for steam and water in the spindle may be loosened and readily blown out as soon as the reassembling is completed.

SAVING TIME.—The element of greatest expense in manufacturing is time, for a little time wasted here and there will lessen and possibly destroy, the year's profits.—*American Machinist.*

SHOP EFFICIENCY

BY ROBERT N. MILLER

Today we are living in an era of productive efficiency wherein all are striving to attain the greatest possible output with the minimum of effort. While as a whole there are many praiseworthy features in the systems developed to attain this end, yet, due often to the method of introduction, several very undesirable features have arisen which have often discredited the whole movement toward scientific management.

To attain the greatest efficiency in an industrial organization there is needed the harmonious co-operation of all the forces involved, and to obtain such co-operation there must exist a feeling of mutual trust and confidence throughout the organization. We often find cases where a so-called efficiency system has been introduced in a plant and yet, after a period of sufficient length for its proper introduction, it has lapsed, leaving the organization with far less of the spirit of co-operation than existed before the system was inaugurated. In fact the system, mainly because of those to whose hands its introduction was entrusted, has really done more toward sewing seeds of discontent among the employees than perhaps any innovation which has been introduced up to the present time.

Wherever the application of scientific management has been honestly worked out we can find material benefit to both the employer and employee, but under the cloak of efficiency engineering we can still find a great deal of faking carried on. It is because of the faking that the chief complaint is raised against efficiency which has for its only object the speeding up of both men and machines. Scientific management rightly construed means the proper correlative action of employer and employee—a co-operation resulting in benefit to both.

The introduction of a system of scientific management must be gradual. Human nature resents the sweeping criticism inferred in an abrupt change of methods. Scientific management is generally accompanied by many changes in methods, and therefore to be ultimately successful it must rely upon winning the sympathy and co-operation of the workman, as well as the foreman and officer. This cannot be accomplished by the mere issuing of instructions; it requires a painstaking campaign of education as to the purposes of the system. The efficiency engineer must, therefore, be a man of extreme tact; he must possess a suaveness that will at all times insure confidence, and above all things else, he must be a keen judge of human nature. The failure of the efficiency engineer to exercise these qualities is one of the chief obstacles in the way of scientific management.

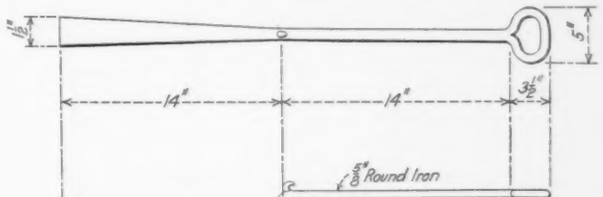
Changing over to the new basis cannot be expected to produce phenomenal results at the very outset, but must be able to show some improvement in a short time. Educating the workman to the system and above all, convincing him that it is finally to result in a larger pay check for him, of course takes time, as it requires an individual study of every man in the shop. It can, however, be greatly facilitated by means of shop demonstrations and lectures. The modern apprenticeship system, wherein the boy is taught the most efficient methods, and above all, where he is taught to use his resources rather than blindly to follow precedent, has done much toward paving the way for the successful application of the principles of scientific management.

It often happens that increased plant output is obtained at the expense of the employees alone rather than by improvements in the methods of production. In order to successfully operate an efficiency system the men must be assured that their increased productiveness will not be offset by decreased pay. Their confidence in the integrity and sincerity of the management must be retained. Ground for the least feeling of suspicion or mistrust tends to destroy the morale upon which the success of the system entirely depends.

PACKING IRON FOR JOURNAL BOXES

BY W. E. JOHNSON
Storekeeper, Chicago & North Western, New Butler, Wis.

The accompanying illustration shows an improved packing iron, designed by P. S. Hoye, car foreman of the Chicago & North Western at New Butler, Wis. The principal feature of this packing iron is the small hook which is placed on the shoulder of the iron for lifting the journal box cover, thus saving the time of turning the iron around to use the handle for this purpose. The length of the spoon is 14 in. instead of 10 in.,



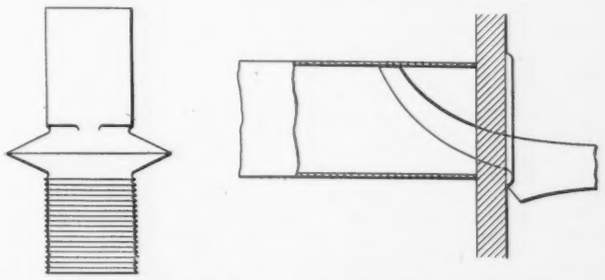
Journal Box Packing Iron with Improved Features

this being sufficient to reach the depth of the largest journal box, without the hook interfering in any way with the manipulation of the packing iron. It is also short enough to prevent contact with the ties when the cover is being raised. This new packing iron has been used at New Butler with very good success, and saves considerable time in inspecting journal boxes.

SPECIAL BEADING TOOL AND BOILER PATCH BOLT

BY PETER E. McINTOSH
Boiler Maker Foreman, Michigan Central, Kalamazoo, Mich.

The beading tool shown in the drawing is designed to prevent the formation of a groove in the tube sheet at the outer edge of the bead on the tube. It is especially intended for use in the roundhouse where it may be handled by an inexperienced man without danger of injury to the tube sheet. It does not require as much material to form the bead as the usual type of tool as it draws the tube out instead of shouldering it up. The foot of the tool should be ground off to fit the size of the tubes with which it is to be used. Many ordinary beading tools are lost by being shot through the tubes with an air hammer. The



Patch Bolt with Groove Above the Threads. Beading Tool Designed to Prevent Grooving of Tube Sheet

shape of this tool is such that it will not enter the tube when in operation farther than as shown in the engraving.

The patch bolt shown in the illustration was designed and has been successfully used by the author for more than a year. Some of these bolts have been placed on the fire line in the firebox and none of the patches in which they have been used have required calking since they were applied. The distinctive feature of the bolt is the removal of the last thread under the countersink by means of a round nose lathe tool, thus forming a slight groove above the threads. Where straight bolts are

used without the formation of such a groove, if the thread is not cut close up to the edge of the countersink and the patch is countersunk to a feather edge, the bolt will tighten into the sheet before a firm contact between the head and the countersink of the patch has been secured, the patch not being drawn firmly to place. On the other hand, in endeavoring to cut the thread close up under the head of the bolt, the edge of the tool will usually cut into the head and spoil its surface. This prevents the proper seating of the bolt in the patch.

REBORING AIR PUMP CYLINDERS

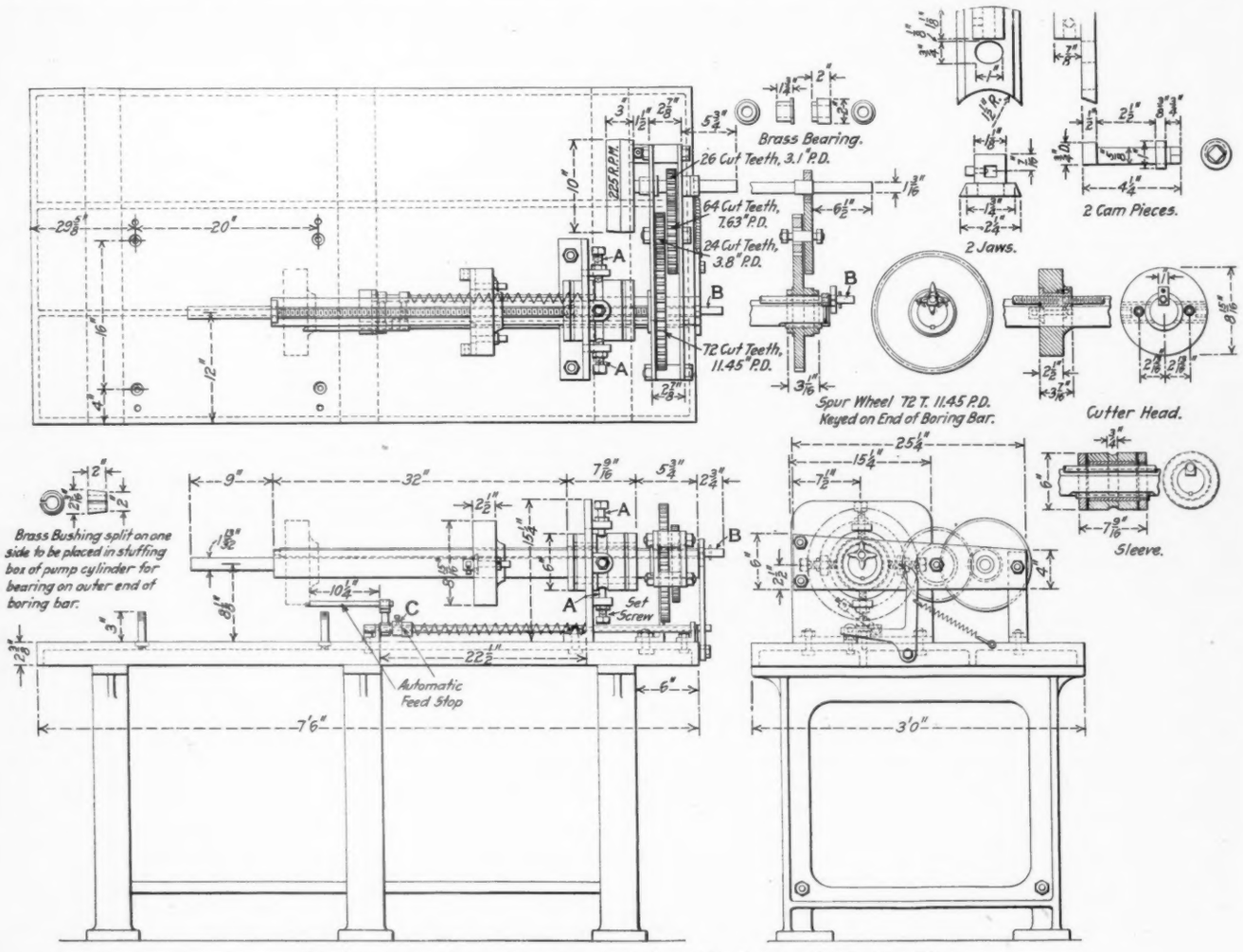
BY J. A. JESSON

The drawing shows a machine which was designed to rebore air pump cylinders without removing them from the center piece. It consists of a belt-driven, star feed boring bar mounted upon a surface plate, the operation being very similar to that of the portable boring bar used in reboring locomotive cylinders. The pump is placed on the bed of the machine and the cylinder to be rebored is slipped over the end of the bar. A split taper bushing of brass is then inserted in the stuffing box and the packing nut screwed on just far enough to hold the bushing in place. The pump may then be placed on the boring bar, the outer end of which is inserted through the taper bushing and centered by tightening the gland nut. After the cylinder has been secured to the bed by means of clamps on the four studs shown in the drawing, the cutter head is set in the counterbore and centered by means of the set screws shown at *A*. By means of a crank on the end of the star feed screw at *B* the cutter head is fed into the cylinder until it strikes the center piece, and the collar *C* of the automatic feed stop is clamped to the pawl release rod by means of a set screw. The cutter head is then run back out of the cylinder, the tools placed in position and the machine started. The tool posts or jaws have a slide bearing in the face of the cutter head which provides for radial adjustment. Cams which are shown in detail on the drawing control this adjustment and are so designed that a maximum variation of ¼ in. in the diameter of cut may be effected without disturbing the setting of the tools. When boring the cylinder the tools are adjusted to the minimum diameter. After the bore is completed the cutter head is fed up to the counterbore at the inner end of the cylinder, the cams adjusted by means of a wrench and a cut taken from the counterbore. The outer counterbore may be finished in the same way, the entire operation requiring but one setting of the tools. A second adjustment of the automatic feed might be desirable before finishing the outer counterbore.

MACHINE FOR BORING DRIVING BOXES

BY E. C. GAINES
Norfolk & Western, Roanoke, Va.

About a year ago the driving box work at Roanoke became so heavy that it could not be handled with one machine. There were no other machines available for this job, and after some careful study it was decided to convert an old car wheel boring machine into a machine suitable for boring driving boxes.


Brass Bearing.
26 Cut Teeth, 3.1" P.D.
64 Cut Teeth, 7.63" P.D.
24 Cut Teeth, 3.8" P.D.
72 Cut Teeth, 11.45" P.D.
225 R.P.M.
2 Cam Pieces.
2 Jaws.
Spur Wheel 72 T. 11.45 P.D. Keyed on End of Boring Bar.
Cutter Head.
Sleeve.
Brass Bushing split on one side to be placed in stuffing box of pump cylinder for bearing on outer end of boring bar.
Set Screw
Automatic Feed Stop
7'6"
3'0"

Machine for Reboring Air Pump Cylinders Attached to the Center Piece

The car wheel boring mill was first stripped and the frame set up on a planer where the top of the base was planed down to form a good bearing for the stationary table. A table 5 in. thick and having a 40 in. by 40 in. top with three T slots was

Old Car Wheel Boring Mill Converted for Boring Driving Boxes

made and securely bolted to the frame of the machine. A bracket to carry an ordinary belt drive was cast and fitted to the back of the frame, the boring bar being driven by means of bevel

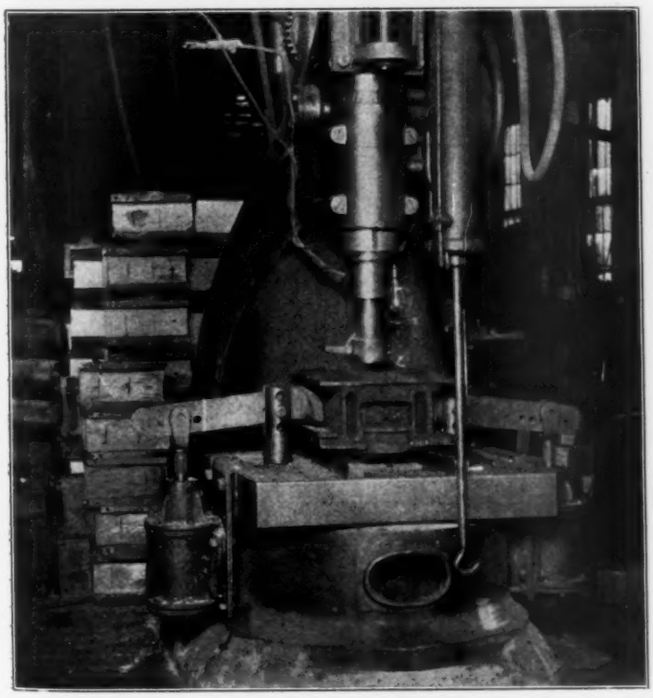


Table and Clamping Device on Converted Boring Mill

gears. The original sleeve was bored out and bushed at both ends to take a 4½ in. boring bar. The original feed, belt driven from the driving shaft, was used, but it was necessary to replace the original lever counterbalance with counterweights inside the frame, two sheaves being secured to brackets within the frame for this purpose. A simple clamping device, the construction of which is clearly shown in the illustration, was installed on the machine, each side of which is operated by an 8 in. air cylinder.

The pulley ratios are such that the bar has a speed of 40 revolutions per minute; the feed is ⅛ in. per revolution, the same speed and feed being used for all sizes of boxes. The time required to bore a box varies from 12 min. to 20 min. The total cost of converting this machine did not exceed $200, including the labor, material and patterns.

THE BEST PRACTICES IN ENGINE HOUSE WORK*

BY DAVID E. BARTON
Bonus Supervisor, Atchison, Topeka & Santa Fe, Topeka, Kan.

Every organization which deals with the performance of work depends on the elements of human activity, primarily, physical and mental. The facilities afforded and the conditions prevailing at the time of the performance have much to do with the results obtained.

Engine houses vary in importance as the amount of work done and the number of engines handled, and also with the class of service in which the engines are used. In selecting men for important engine houses the management generally casts about for the successful men at the smaller points. The foreman is selected on account of his ability to get things done right and at the proper time. He must deal fairly with his men and be able to obtain the best results from a given number, and he must also be in perfect accord with the operating officers with whom his organization is dealing. He must have his work so in hand that he will be able to estimate accurately when he can have certain engines ready for service. He must be able to estimate when an engine which is not in the engine house, and perhaps not off its run, will be ready for service if the operating department requires this information. He must be quick to locate troubles which develop and to apply remedies. He must know when a piece of work needs to be done, when it is done right, have a fairly accurate knowledge of the cost of doing it, as well as the time it should require.

He must have the respect of the men who are working under his direction, and he must be interested in the most minute details as well as have a grasp on the whole situation. He must be able to select men who are capable of performing the various classes of engine house work. He must see to it that the various regulations relative to standards of equipment, etc., are lived up to.

He must be familiar with the keeping of such records and the making of such reports as are required, the use of fuel in the engine house, and the issuing of supplies, and he must exercise the best economy. He must be prompt to execute special orders for power, and have a thorough knowledge of the facilities at hand. He must be diligent, patient, and have the power of concentration, as well as capacity for long sustained effort. He must have full knowledge of all the crafts engaged in the work, be familiar with the most approved methods and be able to keep the work going under all conditions.

Specialists should be used on certain work, such as boiler work, valves and valve motion, pistons and guides, rods, driving boxes, etc., and if not available in the shop force they should be developed. He should see that his men maintain the buildings and shop equipment in good condition.

Comfortable working conditions, facilities for the personal comfort of the workmen, such as reading rooms, clean amusements, and something in the line of educational and social ad-

*Entered in the competition on Engine House Work, which closed July 15, 1914.

vantages, will do much to prevent engine failures and keep down the cost of maintenance of power, by keeping workmen in a contented state of mind, resulting in efficiency.

SOME FACTORS IN LOCOMOTIVE MAINTENANCE

BY E. BECKER
Master Mechanic, Chicago & North Western, Escanaba, Mich.

Considering conditions as far back as 1885, when locomotives were painted with drop black, the best kind of varnish was used and all repair work was well done, brings more clearly to mind some of the more important repair items which, if properly taken care of, will assist greatly in keeping power out of the back shops and hospital tracks, and thereby increase the mileage between shoppings.

The care of wedges is one of the most important items. If properly kept up, the wedges not only prevent excessive wear in driving boxes and brasses, shoes and wedges and rod brasses, but do a large share toward avoiding loose and broken crossheads, broken front cylinder heads and broken frames. If an extra man is placed in charge of this work, the care of driving box cellars and the keeping tight of binder bolts, it will take but a short time to show that these items will relieve the back shop of a large amount of work.

Valve motion should be watched carefully; never allow a "lame" engine to run; close inspection should be made and the trouble corrected. This can be done in any ordinary roundhouse. If necessary close the eccentrics and perhaps apply bushings in the links, transmission bars and hangers

Tire work, rod brass renewals, the babbitting of crossheads, etc., can all be done in roundhouses. Lateral play in trailing and engine truck boxes should also be looked after in roundhouses. In an article in the Railway Age Gazette some time ago, reference was made to increasing the wheel and driving box face to give a larger side bearing and avoid lateral wear. In my opinion this is wrong as it would mean more friction and would be a disadvantage on sharp curves.

Careful inspection should be made of all tires. Good inspectors are valuable assets, and we should be more careful in selecting the men for this important work. Wheels, and especially steel tired engine and tender wheels, should never be allowed to run to the limit as to sharp flanges; this is a dangerous condition in the first place and moreover it then becomes necessary to turn off too much metal from the tread of the wheel in order to again obtain the proper flange. Little or no attention is given to determining why at times one flange out of four in a tender truck becomes sharp. Few roundhouses or shops tram the wheels and square the trucks properly; I have never found four wheels under a tender sharp at one time and if the practice is followed of carefully tramming the wheels to see that the truck is square, I can see no reason why one wheel should become sharp out of four.

Boilers should be washed not less than three times a month, taking water conditions into consideration. I believe that in most places it will be found that there are not enough boiler washers employed. If the matter of boiler washing is kept up it will avoid a great deal of boilermaker's work and help greatly to preserve fireboxes and tubes. A good blow-off system and the free use of soda ash will go far to eliminate scale and mud from boilers. Care should be taken to keep tubes free from soot; they should be blown out at every washout, the brick arch taken down and the tubes candled; the calking edges should be watched very carefully and kept free from burrs.

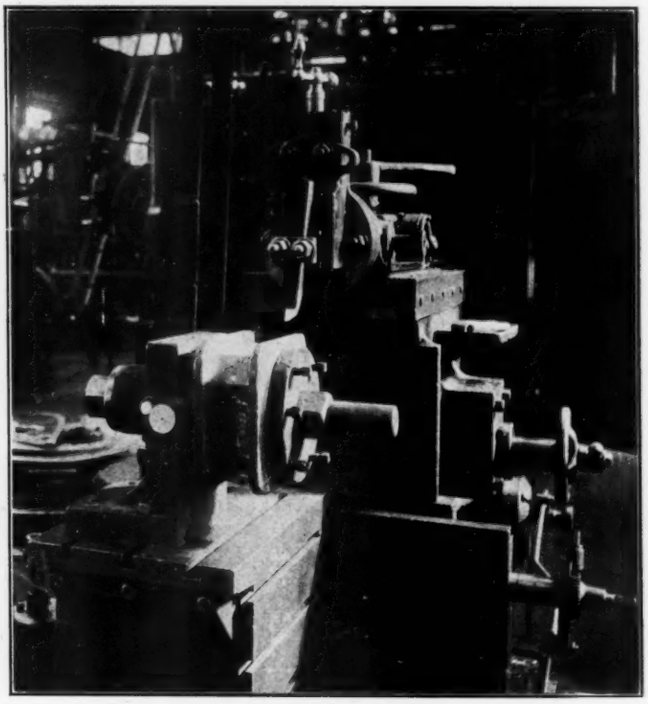
All tools which are standard should be inspected once every 30 days by a competent man.

The importance of the positions of the various foremen should not be overlooked. These men hold responsible positions and should be selected from the ranks of the best mechanics; they should have the ability to handle men as well as to direct the work and see that it is properly done, as my experience has indicated that much money is paid out for poor work which has to be done over again. How many foremen personally watch the work to see that it is properly done? Close supervision of details is very desirable and with good judgment and a little common sense, will help materially in the economical maintenance of power.

INDEX HEAD FOR HOLDING ROD BRASSES

BY F. J. DAILY

A jig for holding rod brasses while being finished on a shaper is shown in the illustration. The two parts of the brass are clamped between two circular plates which are pivoted to the vertical face of an angle plate secured to the shaper table. The brass is held securely in place by means of six set screws in the outside circular plate and it has been found that sweating the two parts of



Finishing Rod Brass in Index Head on a Shaper

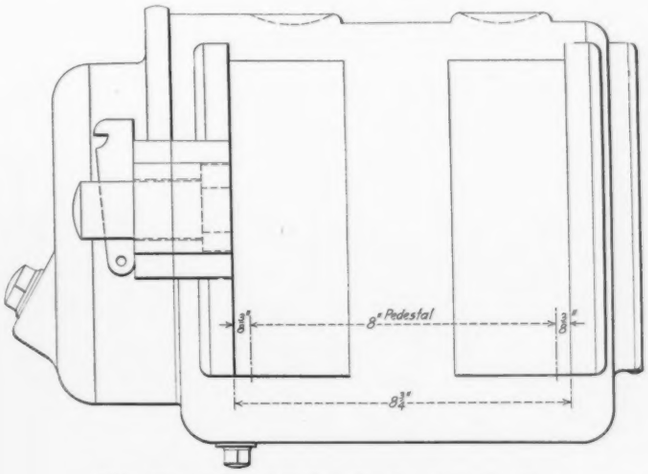
the brass together is unnecessary. The entire chuck revolves about the axis of the clamping bolt and is fitted with an index head divided into quarters for machining the four sides of the brass. Before chucking the brass the adjoining faces of the two pieces should be finished and the ends faced.

A Spanish Car Building Plant.—The annual report for 1913 of the Spanish Metallic Construction Company, of Madrid, shows that the company's business for the year totaled $2,888,000, an increase of $449,100 over 1912. The company has five plants and the number of men employed is 1,800 as against 1,650 in 1912. The chief factory of the five is at Beasain, province of Guipuscoa. This plant alone built during the year 1,250 flat cars and five first-class passenger cars for the Northern Railway; 1,215 freight cars of various kinds, and 43 first-class passenger cars for the Madrid Saragossa & Alicante Railway; 4 first-class and 3 third-class passenger cars for the Oviedo-Hendaye Railway, besides a number of cars of various kinds for companies and individuals. This plant has a capacity of 3,000 freight and 200 passenger cars per year.

NEW DEVICES

ROLLER JOURNAL BEARING

A journal box with roller bearings for use in equalized trucks of the pedestal type is shown in the drawings. It was developed by the Anti-Friction Roller Bearing Company, 88 Broad street, Boston, Mass., and is so designed that no lateral movement takes place between the box and the axle, provision being made for this movement between the journal box and the truck frame.



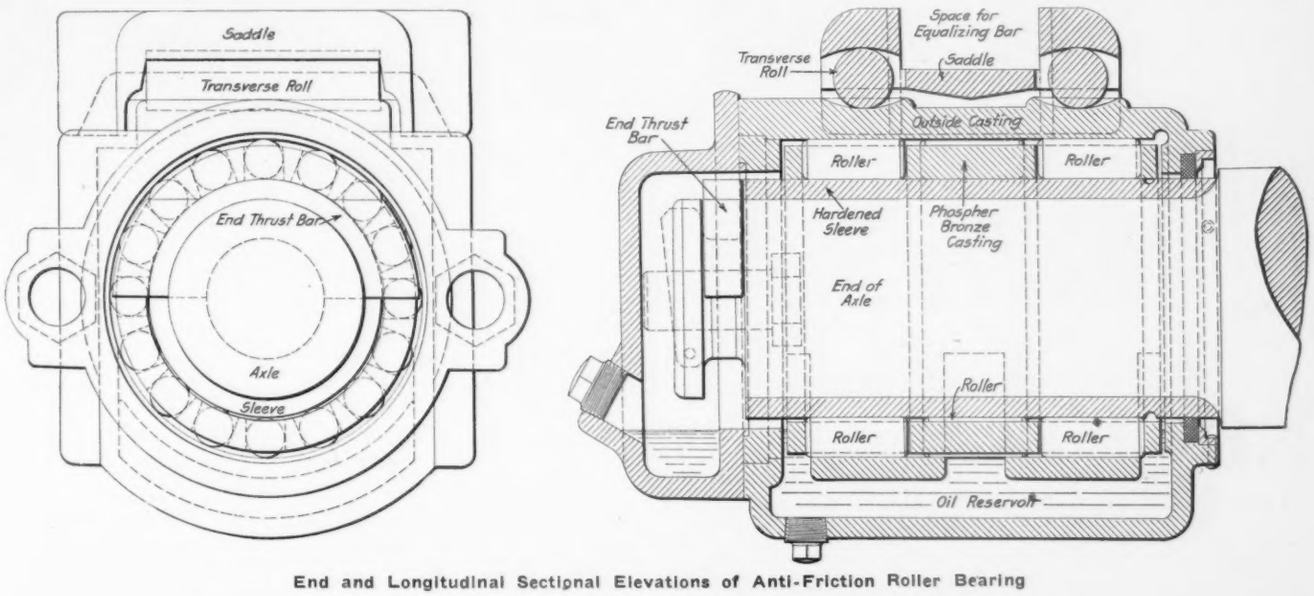
Side Elevation of Roller Bearing Journal Box

The journal box is of cast steel with casehardened roller surfaces and is provided with an oil reservoir in the bottom. In applying the bearings to existing axles the journal is turned down as shown in the sectional drawings and fitted with a sleeve of low carbon steel, which is pack hardened on the outside and pressed into place on the journal. The rollers thus run on hardened surfaces and the wear is very slight. The rollers, which are solid, are slipped into slots in a phosphor bronze casing and are divided into three longitudinal sections of 16 rollers each. This construction was used in order to reduce the trouble from slippage should one end of the journal bearing or of the box wear faster than the other, and it is claimed to have proved successful in operation.

Lateral motion between the journal box and the axle is prevented by an end thrust bar of phosphor bronze. This bar rides in a groove in the end of the axle and at either side projects into pockets in the journal box cover, which are closed at the rear by the face of the box. It may be readily renewed by removing the cover from the box. As shown on the side elevation of the box, the distance between the pedestal flanges is ¾ in. greater than the width of the pedestal. This permits the necessary lateral motion of the axle relative to the truck frame, the motion being controlled by the saddle and transverse rollers resting on the top of the box. The saddle is held in position by the end of the equalizer while the rollers provide for the lateral movement of the journal box. The contour of the roller surfaces on the box and on the saddle tends to retain the axle in a central position under normal conditions when running on straight track.

The journal box cover is held in position against the face of the box by two T-bolts and taper keys, which facilitate the quick removal and replacement of the cover for examination or renewal of the bearing. The cover need seldom be removed in service, however, as the bearing may be oiled by removing a plug provided for that purpose. The roller cage is held in place by a forged ring which seats against a shoulder in the end of the box and forms a portion of the cover joint.

Oil is carried in the well in the bottom of the box to such a height that the rollers dip as they revolve and carry the oil to all parts of the bearing. A felt washer, secured at the rear end of the box by a metal ring, keeps the interior free from dust, and oil is retained by a groove turned in the surface of the journal between the bearing and the end of the box. Service tests indicate that the bearing requires oiling about once in three or four months.



End and Longitudinal Sectional Elevations of Anti-Friction Roller Bearing

A test to determine the durability of this bearing was conducted during a period of about 18 months on a 50-ton passenger car originally fitted with 5 in. by 9 in. journals. Dur

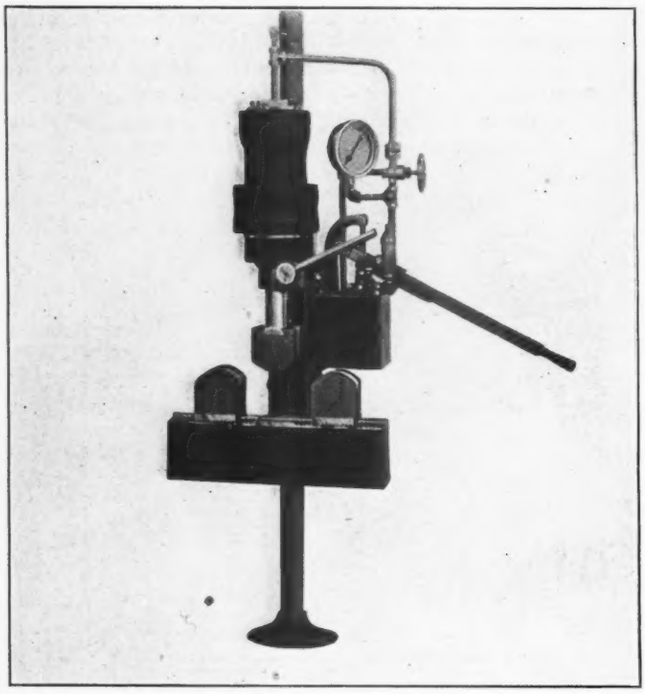
ing the test the bearings made about 80,000 miles and ran approximately 20,000 miles on one oiling. At the end of the test the rollers, sleeves and other parts of the bearings had acquired a high polish, but are claimed to have shown no other evidences of wear. Repacking the box and renewing brasses being entirely eliminated, the cost of maintenance was reduced to the occasional oiling of the bearings.

HYDRAULIC PIPE BENDER

The engraving shows a press which was primarily designed for bending pipe of various sizes but which is also suitable for miscellaneous work, such as bending small structural shapes, straightening bars, shafts, etc. It is provided with clamps by which it may be attached to a stanchion, the diameter of which is not over 5 in., and it will bend pipe up to 4 in. in diameter.

The press is of steel throughout. The frame and bending bed are cast in one piece; the top of the frame is provided with a ring in which the cylinder sets. The construction is such that the cylinder may be turned to any desired position in the ring and keyed in place, thus bringing the handle of the ram pinion to the point most convenient for the operator. The bending blocks are held in position on the base by means of serrations which interlock with corresponding serrations on the surface of the base, and are readily changed without the use of a wrench.

The ram is forced downward by a hand-operated pump of which the reservoir forms a part. The pump has a plunger diameter of 5/8 in., and a stroke of 3½ in., and is equipped with a ½ in. safety valve and ½ in. tee wheel operating valve. A hand-operated pump is especially desirable on a press of this



Hand-Operated Hydraulic Pipe Bender

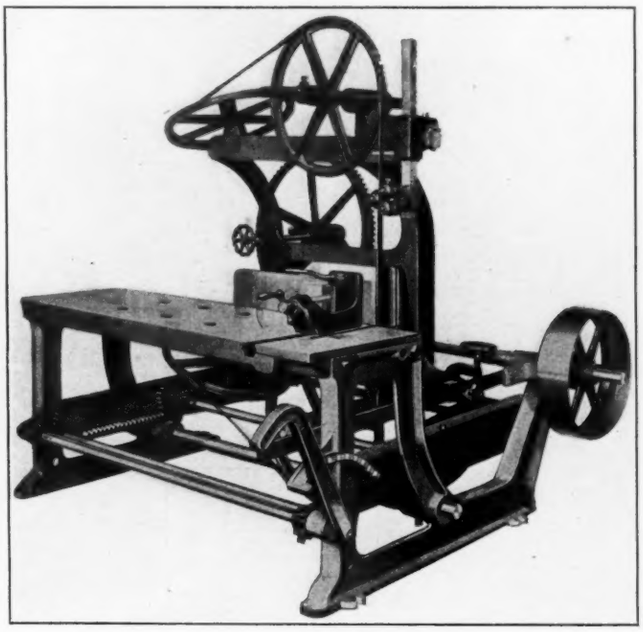
kind because the facility with which the ram pressure may be controlled greatly reduces the danger of over-bending the material. A rack and pinion is provided for the rapid movement of the ram to the work before the pump is operated. As the ram moves downward the cylinder fills with liquid, the upward movement returning the liquid to the water box. There is thus no lost motion in the operation of the pump.

The ram has a diameter of 6 in. and a run of 9 in. The pressing bed which receives the bending blocks is 27 in. long and has a pressing width of 8 in. The clear height between the ram head and pressure bed is 14¼ in., and the height of the press over all is 3 ft. 11 in. It is manufactured by The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, and develops a maximum pressure of 30 tons.

VERTICAL BAND SAW FOR METAL CUTTING

The metal band saw shown in the illustration cuts at any angle and has been developed by M. E. Shinn & Co., 1846 West Lake street, Chicago. The cutting portion of the blade operates vertically and is automatically fed by gravity, the angle of the saw blade remaining unchanged as the cut progresses.

The material is supported on a table provided with a radial back and a vise operating in a slot across the table. By adjusting the radial back material may be cut at any angle desired. The lug shown at the right end of the radial back is secured



Gravity Feed Metal Band Saw

to the table by a single cap screw, so that it may be readily removed, thus leaving the table clear for the handling of longitudinal work. Any length of work may be handled longitudinally, as there is a clearance of eight inches between the saw and the arbor frame.

The non-cutting or return part of the blade passes over wheels arranged to carry it back to a point where it will clear the material being cut, while the cutting part of the saw is held in a vertical position and is free from twists. The saw arbor is mounted upon four ball bearing wheels, to one pair of which gears are attached. The wheels travel in channels which keep the arbor in alinement as it is fed into the work, and the gears operate in racks which insure uniform travel of both sides of the arbor. The feed is effected by inclining the plane of the channels. The inclination of the tracks may be altered by an operating lever at the right side of the machine and the feed thus regulated to suit the thickness of the work. The action of the saw is entirely automatic; a trip which may be adjusted to any width of material stops the saw after the cut is completed.

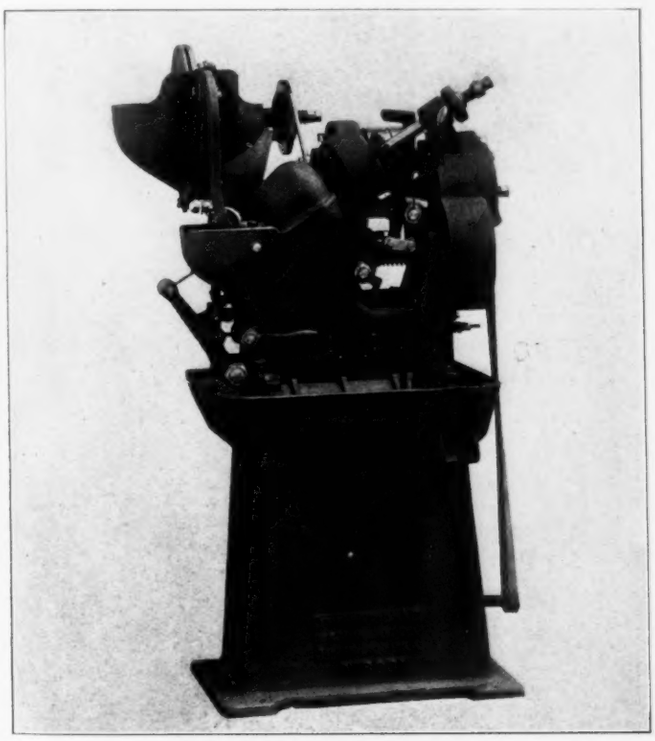
This machine is capable of taking material up to 11 in. by 12 in. in section. At ordinary operating speeds it will cut off cold

rolled steel shafting 2½ in. in diameter in about three minutes, while a 6-in. shaft requires about 23 minutes. The band saw used is 15 ft. 6 in. long, ⅝ in. wide and .0312 in. in thickness. The table is 42 in. long and is 18 in. from the floor, a low table being used in order to facilitate the handling of heavy material. The machine shown in the illustration is designed for a single belt drive, but a back geared motor drive can be applied if desired.

AUTOMATIC NUT TAPPING MACHINE

An automatic nut tapping machine using a bent tap to provide for continuous operation without reversing the direction of the tap is shown in the accompanying illustration. This machine was developed by the National Machinery Company, Tiffin, Ohio, and is being built in sizes to handle ¼ in., ⅜ in., ½ in. and ¾ in. nuts.

The hopper in which the blanks are placed is of large size, being designed to hold about 80 lb. on the smaller size machines. The nuts are moved from the hopper to the feed chutes by means of a vane type feed mechanism and are carried down the chute by gravity into position against the starter. There are four of these feed vanes and they are so enclosed that the weight of the blanks does not interfere with their operation. They are driven by a ratchet and pawl from the driving shaft. The ratchet is



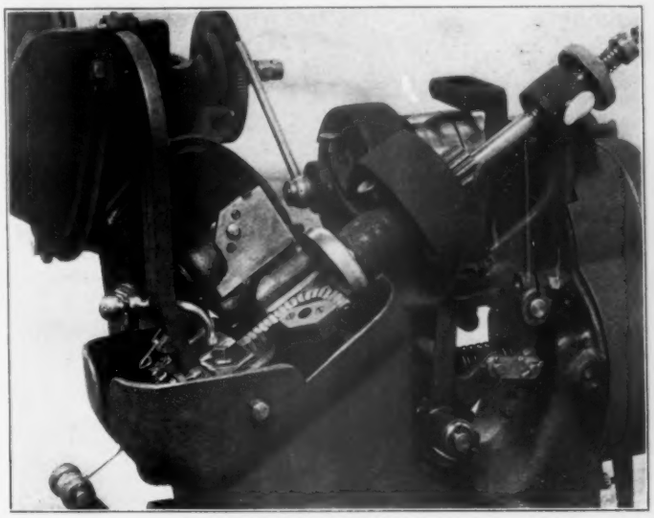
Automatic Nut Tapping Machine in Which a Bent Tap Is Used

held between friction flanges which allow it to slip in case thin blanks wedge in the feed groove and interfere with the movement of the vanes, thus preventing damage to the machine.

The tap spindle and starter are inclined, thus causing the face of the blank to lie against the starter. The lubricant keeps the face of the starter washed free from chips so that the blank is always tapped at right angles with the bearing face. After the nut has been started on the tap it is held stationary and the spindle is fed into it during the completion of the operation. By thus holding the nut the difficulty due to binding in the guides, which is often experienced where the nut is fed onto the tap, is overcome. The tap spindle has a slight lateral travel and is counterbalanced, giving the spindle a floating movement.

After the nut has been tapped it travels up the shank, through the head and off the end of the tap, as shown in one of the illustrations. The hood over the head serves to direct the nuts into a chute by which they are conveyed out of the machine into kegs or boxes. An automatic belt-shifting device is provided by which the machine is stopped in case a slug or an improperly shaped blank should pass over the tap and jam against the head.

These machines are designed primarily for tapping square nuts, but hexagonal nuts can be handled. Each size of machine may be arranged for handling both styles of nuts, as well as

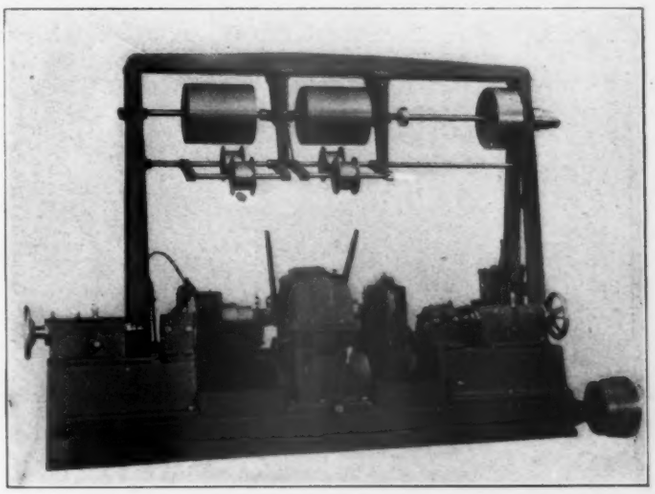


Head of Automatic Nut Tapping Machine Opened, Showing Course of Finished Nuts

several sizes, and by making a simple gear change the rate of feeding can be regulated to suit the kind of nuts being tapped. The ⅜ in. size machine is recommended for operation at the rate of 30 United States standard nuts per minute.

CAR WHEEL GRINDER

The illustration shows a car wheel grinding machine which has recently been developed to handle either steel or cast iron wheels which may be centered either on dead centers or on their own axle journals, as desired. It is manufactured by the Springfield Manufacturing Company, Bridgeport, Conn. Wheels



Self Contained Car Wheel Grinding Machine

of any diameter from 28 in. to 44 in. may be handled and provision is made for centering journals up to 6 in. in diameter.

The machine is self-contained and is driven by one belt, either

from a line shaft or by a motor mounted on the base. The countershaft is mounted on a frame which is placed in front of the machine in order that the space directly above the centers may be unobstructed.

The axle is driven by a gap gear at the center from two driving pinions which are widely spaced to overlap the gap in the driven gear. Both pinions are driven by the same shaft in order to insure correct relative action at all times. A clutch which is operated by hand levers from either side of the machine facilitates stopping the axle accurately when the gap in the gear is properly located to permit the removal of the axle. Three different axle speeds are obtainable.

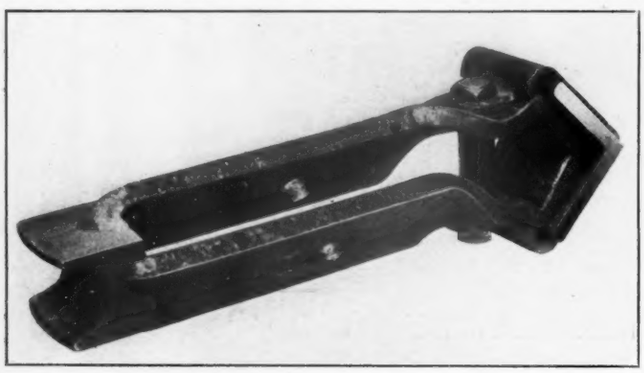
The grinding wheel spindles are driven by a belt from drums on the countershaft, the proper belt tension being automatically secured by means of idlers. Cone pulleys on the spindles provide two different speeds for the wheels. The spindle heads slide in swiveling bases which permit of taper grinding. The slide bearings are of the long narrow type and are provided with taper gibs to take up wear. A feed screw of large diameter is used, at the end of which is placed a ball thrust bearing. Both the feed and the transverse are hand operated. Grinding wheels 18 in. in diameter are used, operating at speeds of 1,040 and 1,350 revolutions per minute, the axle being driven at speeds of 4.2, 5.3 and 6.5 revolutions per minute. Water is delivered to the grinding wheels by means of a suitable pump of ample capacity, part of the bed forming the supply tank. Hoods are placed over the wheels to confine the spray.

Large sleeves and feed screws are used in the tailstocks, which are provided with both dead centers and wabble centers. The dead centers are necessary when grinding engine truck wheels and the wabble centers are provided to prevent axles from moving laterally when grinding wheels on their own journal bearings. The journal rests are designed to receive split bushings of varying diameter, each of which is itself adjustable for slight variations in the diameter of journals.

This machine has a capacity of about 20 pairs of 33 in. wheels per 10-hour day, the exact rate depending upon the condition of the wheels and the amount of stock to be removed. When motor-driven a constant speed motor of 20 hp. is required. The net weight, including the motor and accessories, is about 18,000 lb.

FORGED BRAKE BEAM FULCRUM

The brake beam fulcrum shown in the illustration has been developed by the Damascus Brake Beam Company, Cleveland, Ohio, to replace the malleable iron fulcrums now generally used. This fulcrum is a solid steel forging, one end of which is provided with a seat for the tension member of the beam and the other fitted to the structural compression member. The fulcrum is held in position against the latter by means of a bolt and clamping plate clearly shown in the illustration. As shown, the fulcrum is designed for application to the Anglrod brake beam, but both the tension and compression member ends may be formed to fit any type of beam.



Forged Steel Brake Beam Fulcrum

ADJUSTABLE FIRE DOOR PEDAL

An adjustable pedal has been developed by the Franklin Railway Supply Company, 30 Church street, New York, for use in operating pneumatic fire doors. The tread is mounted in a pedal hanger in which it has a sliding adjustment to permit

Adjustable Fire Door Pedal Removed from the Door

Adjustable Pedal Attached to the Franklin Butterfly Door

moving it farther from the boiler head as the coal is used out of the tender. The tread may also be adjusted for either a tall or a short fireman, a lock being provided which holds it in any desired position. The hanger is mounted on a rigid hanger bolt about which it may be swung in either direction by raising it to clear the teeth in the face of a shoulder on the bolt. When swung to the desired position it is secured by dropping it into place, the teeth in the hanger engaging those in the shoulder. Vertical adjustment of the hanger is provided so that in case of a warped deck the tread may be raised to the proper clearance, making it unnecessary to take the hanger to the blacksmith shop. This adjustment is made by turning the rigid hanger bolt, which is threaded in the fulcrum. One side of the fulcrum is slotted and when the proper adjustment has been made the bolt can be locked in place by means of a bolt provided for that purpose.

PNEUMATIC PLATE FLANGING CLAMP

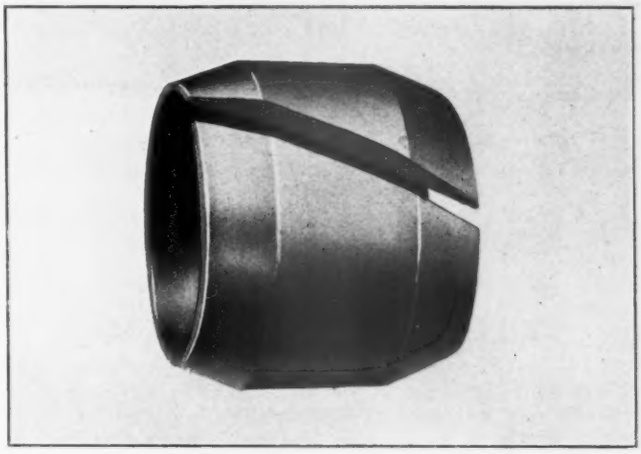
The accompanying illustration shows a plate flanging clamp on which the clamping beam is not only raised and lowered by air pressure, but also clamped by this means. The machine is built by the Niles Bement Pond Company, New York. On previous designs the top beam was elevated by air pressure, but it was clamped by means of screws with hand-wheels.

The upper beam is moved by four cylinders. There are two lower and two upper pistons, the lower ones being used for elevating and lowering and the upper ones for clamping the beam. These operations are all controlled by means of a three-way valve. The corresponding cylinders are designed to operate simultaneously. The upper beam is held in machined slots in the upper pistons, and means are provided so that the top beam adjusts itself to give an even distribution of the load, when clamping plates of uneven thickness. The upper pistons have a bearing in the frame which prevents any side motion of the pistons and upper clamping beam.

This machine is furnished in several sizes, the one illustrated having a capacity for plates 12 ft. wide. The clamping cylinders exert an effective pressure of 15 tons at an air pressure of about 80 lb. per square inch.

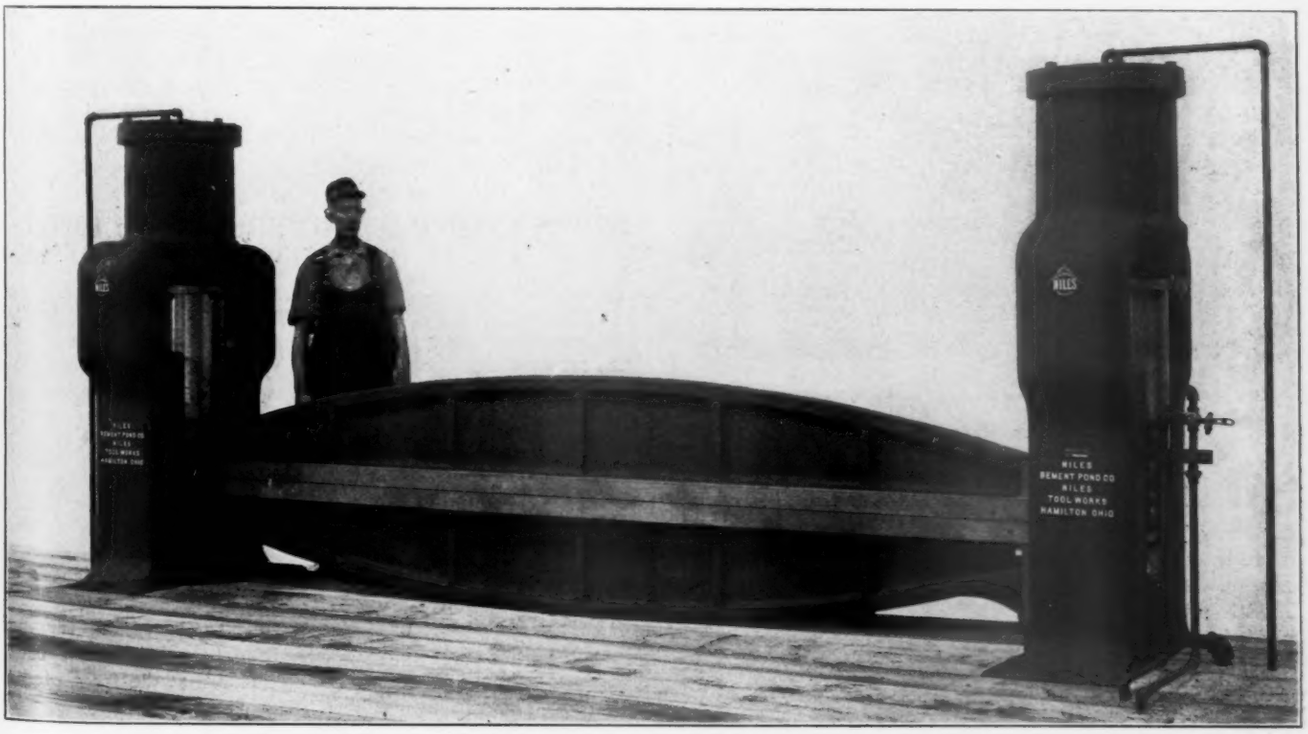
SAFETY HOSE CLAMP

The hose clamp shown in the illustration was originally developed for use with its oil burning equipment by the Mahr Manufacturing Company, Minneapolis, Minn., and was intended to eliminate the danger arising from failure of the type of clamp now generally used. These clamps are made for all sizes of hose and provide a safe coupling for use with oil, steam or hot water hose, where a failure of the coupling is dangerous.



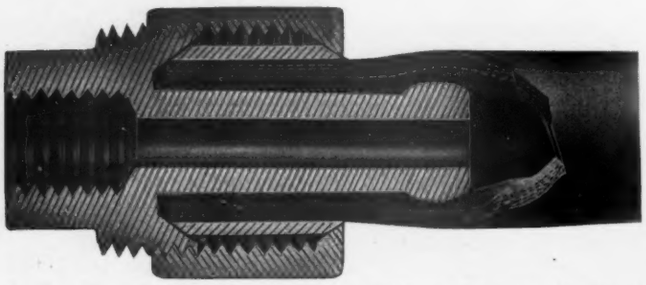
Clamping Sleeve Used in Safety Hose Clamp

By referring to the sectional elevation of the coupling it will be seen that a nipple having a knob on the end extends into the hose which is surrounded by a wide spirally-split clamping sleeve, beveled on each end. The beveled surfaces are brought into sliding contact with corresponding concave



Pneumatic Plate Flanging Clamp

surfaces in the body of the coupling at one end and in the clamping nut at the other by screwing the clamping nut on the body of the coupling. The resulting closure of the sleeve



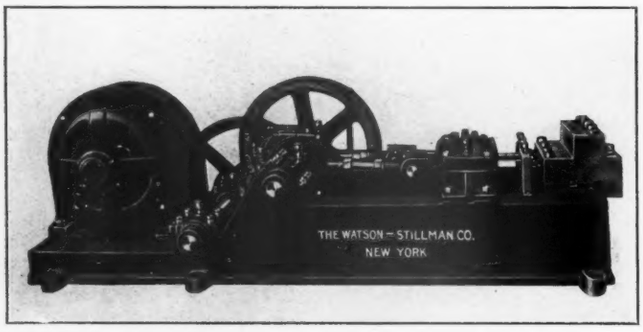
Section Through Hose Clamp Showing Method of Gripping the Hose

effects a firm grip on a considerable length of the hose and practically eliminates the danger of failure from slipping of the joint.

TRIPLEX HYDRAULIC PUMP

A motor-driven triplex single-acting pump which embodies several special features has been added to its line of high-pressure hydraulic pumps by the Watson-Stillman Company, 50 Church street, New York. While primarily designed to meet the requirements of tunnel service it is equally adaptable to other classes of work.

To secure compactness and rigidity the motor is mounted on an extension of the heavy cast iron base. This also insures perfect alinement between the motor and the pump. The pump body is a machine steel forging fitted with bronze valves and bonnets, and is designed to eliminate all air spaces. The passage-



Motor-Driven Hydraulic Pump

ways are made large to reduce friction of the water to a minimum. The plungers are of tool steel and are guided in a rigid crosshead guide which is keyed and bolted to the base. They are driven by eccentrics which are cast in one piece and keyed to the driving shaft, the eccentrics being spaced 120 deg. apart. The driving shaft and bearings are of large proportion and are provided with ample lubrication. The power transmission gears are heavy and have cut teeth throughout. The pump as shown is operated by a 10-hp. motor running at 600 R. P. M. and delivers 100 cu. in. of water per min. at a pressure of 3,500 lb., the speed of the crank shaft being 100 R. P. M.

Russian Bath Train for the Front.—It is stated that the Russian ministry of ways and communications is sending to the front a bath train of over 20 cars, providing 2,000 baths daily. There is a tank car in case water is unobtainable at any stopping place. Soldiers can be given clean underclothes from the stores carried. There is also a car for drying and disinfecting outer garments and a restaurant car.

SAND BLAST HELMET

In the accompanying illustration is shown a helmet which is designed to protect the eyes, face and head of the operator of a sand blast machine from dust and flying sand. The helmet is made of brown canvas, is strongly constructed and is comfortable to wear. As shown in the illustration the rim projects well beyond the operator's face, thus enabling him to turn his head freely without coming in contact with the curtains, which are of sufficient length to descend over the shoulders and effectively exclude sand and dust. The construction is such that there is free circulation of air around the head between the sweat band and the body of the helmet.

Sand Blast Helmet

Ventilation is facilitated by the eye piece which is usually made of fine wire netting that does not impair the vision and is not affected or dimmed by the action of the flying sand or by dampness, as is glass. When so desired, however, a celluloid strip may be substituted for the wire gauze, but as a rule this is not recommended. The helmet is manufactured by J. M. Betton, 26 Park Place, New York.

HEAVY DUTY UNIVERSAL MILLING MACHINE

In the accompanying illustrations is shown a universal double back geared milling machine designed for heavy duty, which has been recently introduced by the Rockford Milling Machine Company, Rockford, Ill. This machine is of the knee type, with an especially rigid overhanging arm and a vertical brace for the outer end of the arbor. It is driven by a 3 in. double belt on a three step cone pulley.

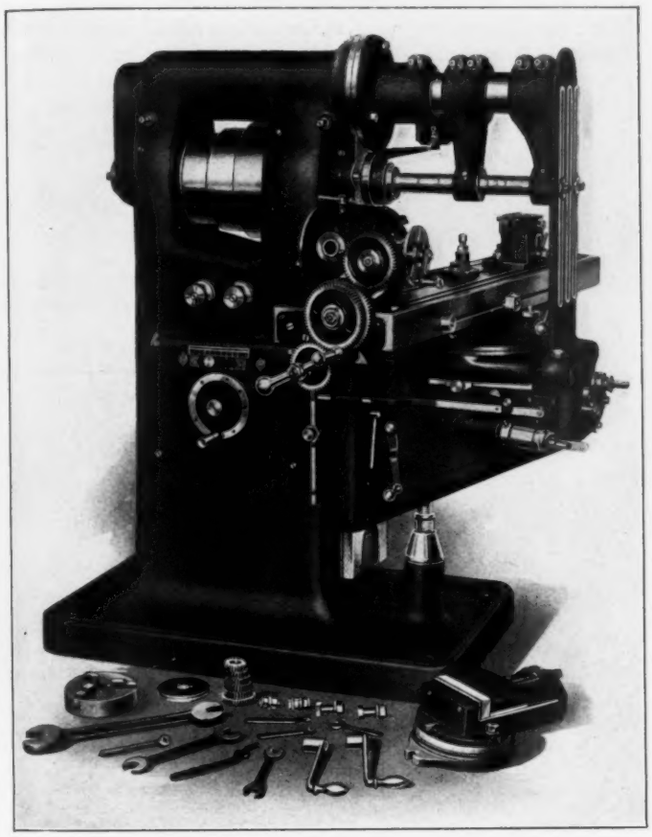
The spindle runs in phosphor bronze bearings which are provided with means for taking up the wear of both bearings in one operation. The spindle is 3 in. in diameter. It is fitted with a Brown & Sharpe No. 11 taper socket and a 1 in. straight hole extending through to the end of the spindle.

The spindle speeds are in geometrical progression, ranging from 17 to 392 r. p. m. in either direction. The double back gears are enclosed in the column and placed at the front of the machine. This arrangement brings the gears close together, and is claimed to prevent chatter when taking heavy cuts. All gears are of liberal diameter with wide surfaces and coarse pitch.

The table has a working surface of 50 in. by 11½ in. It is provided with quick return motion and is designed to swing through an arc of 300 deg. The table feed gearing is driven by a chain which is enclosed in the column to protect it from dust. The feed changes are 14 in number, ranging from .005 in. to .175 in. per revolution of the spindle. Only two levers are required to make all feed changes. The maximum length of automatic feed is 28 in. for longitudinal, 8 in. for the cross feed

and 19 in. for the vertical feed. If desired, however, the machine may be specially provided with longitudinal and vertical feeds of 34 in. and 20 in. respectively.

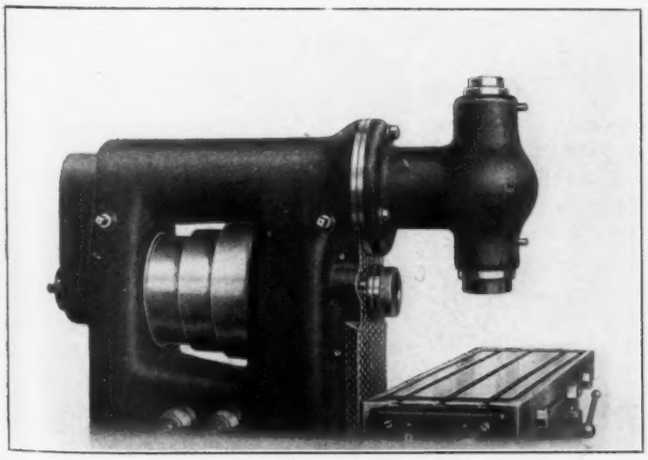
The overhanging arm is of solid steel 4 in. in diameter and is provided with two bronze bushed arbor supports. It is held



Double Back Geared Universal Milling Machine

in position by a flanged support which is secured to a solid flange on the face of the column.

The vertical milling attachment, which is shown in one of the illustrations, is not driven through the main spindle nose as is usual in knee type milling machines. When placing the attach-



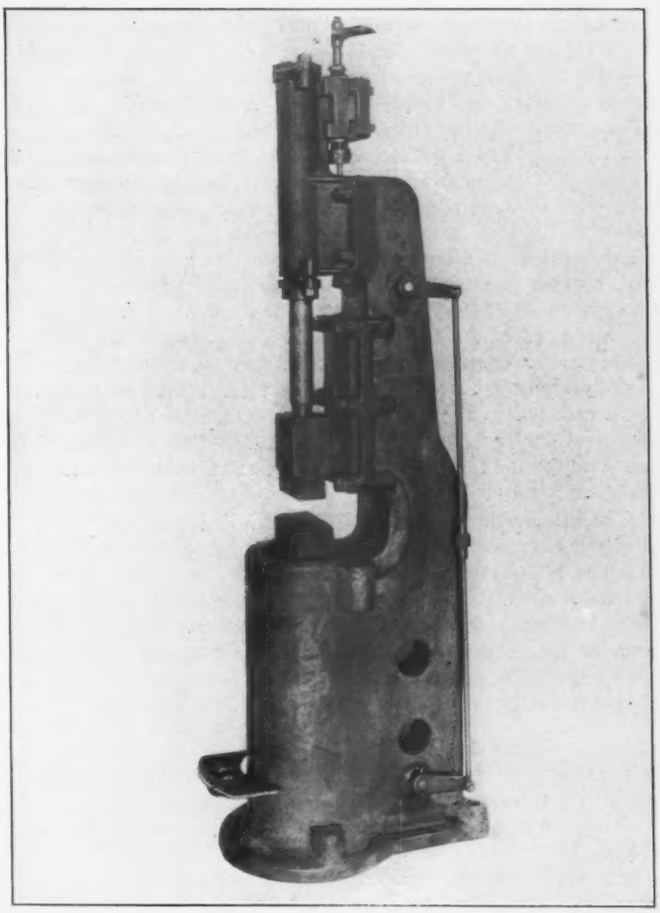
Vertical Milling Attachment in Place

ment on the machine the overhanging arm is removed and a sleeve in which runs a driving shaft inserted in its place. The attachment is clamped to the flange on the main column and its spindle driven by the shaft, through beveled gears which form a part of the attachment. The shaft is driven through a geared connection back of the main spindle, by the use of an idler gear. This arrangement provides the same range under the vertical attachment as is permitted under the main spindle, and also leaves the main spindle free for use on certain kinds of work without dismantling the attachment or removing work from the table, it being only necessary to turn the lower arm of the attachment out of line with the main spindle.

The machine is provided with a spiral dividing head which will swing 10½ in. in diameter and take 24 in. between centers. Its spindle can be set at any angle from 10 deg. below horizontal to 10 deg. beyond perpendicular. A vise attachment having a graduated swivel base and a maximum opening of 3½ in., as well as a three-jaw chuck 6 in. in diameter are also included in the equipment of the miller. The net weight of the machine is 3,800 lb.

PNEUMATIC LIGHT FORGING HAMMER

The illustration shows a light forging hammer for operation by compressed air which was designed to handle tool dressing, light bending and straightening, and the miscellaneous forging work which is usually done by a blacksmith and helper. The use of compressed air permits its location at points in the plant where



Pneumatic Forging Hammer for Light Work

steam is not available. Air from the shop system at 80 lb. to 100 lb. pressure is used, a ½-inch pipe or hose connection being required.

The heavy anvil block is cast in one piece with the frame to which the cylinder is keyed and bolted, the key extending entirely across the face of the joint. The guides for the ram are also secured to the face of the frame. Side housings were

avoided in the design in order to keep the working space clear and to facilitate observations of the work under the hammer. All important bolts have double nuts to prevent them from jarring loose. The piston and piston rod are formed from one piece of chrome-vanadium steel, oil treated, while the hammer head and guide shoe are made in one piece of high carbon steel. The guide shoe is of large area and the piston rod has a long taper fit in the ram. The dies, which are removable, are of special die steel with hardened faces.

The piston is packed with cast iron snap rings. In order to facilitate the examination and renewal of the rings the piston rod stuffing box gland is split so that it may be readily removed. The piston may then be raised above the top of the cylinder and inspected without the necessity of removing the ram from the piston rod.

The plain forging dies shown in the illustration are regularly furnished with the hammer, but special dies of any form may be quickly substituted. For accurate die work, such as forming and stamping light sheets, the anvil is furnished with three heavy cast lugs spaced 120 deg. apart. These are fitted with hardened centering screws by means of which the lower die may be accurately alined with the upper one. In order to provide clearance for the work the frame is recessed at the top of the anvil and the front and back walls are removed, thus permitting the passage of long stock through the frame when it is desired to work the stock across the die.

The air admission to the cylinder is controlled by a simple slide valve designed to remain tight regardless of wear, and provided with special ports to give the control desired. The valve is operated by the foot lever shown at the front of the anvil. This lever is depressed by a slight pressure of the foot and returned to its upper position by the pull of a coil spring located in a pocket at the front of the anvil. When air is admitted to the valve chamber the ram rises to its upper position and on depressing the foot lever it strikes a quick, snappy blow of great force. Upon releasing the lever slightly the ram rises instantly to its upper position, where the piston is air cushioned so that it cannot strike the cylinder head. The hammer readily responds to variations in the foot pressure and it is claimed that with a little practice the range of operation may be varied from light, rapidly repeated blows of short height for use in straightening light material to the maximum force of the hammer, which is sufficient for the reduction of 2-in. stock. The foot control is especially suited to the miscellaneous class of work for which the hammer is adapted.

The hammer is manufactured by H. Edsil Barr, Erie, Pa. An important consideration is its comparative freedom from limitations as to location, being independent both of line shafting and a steam supply. It is built in two sizes, one weighing 800 lb. for light tool and soft metal work, and the other weighing 1,200 lb. suitable for general forging operations on material 2 in. square or smaller. The larger hammer occupies a floor space 14 in. by 24 in. and stands 5 ft. 6 in. high.

TALC AS A LUBRICANT.—A German chemical journal contains an article relating to the use of talc for lubricating purposes. Talc does not behave like graphite when treated with tannin solutions, but it may be brought into a fine molecular state by heating it with ammonium carbonate or by exposing it for several hours to a current of dry ammonia. The talc is afterward dried in a vacuum. The treated material can be suspended in water so that it is very difficult to filter it, and subsides very slowly in lubricating oils of medium density. When once suspended in a neutral oil, the talc does not subside on heating. The change in the character of the talc is attributed to the absorption of a minute quantity of ammonia. From 40 to 60 per cent of ordinary talc may be introduced into heavy mineral oil, provided the oil is added to the talc and the operation not carried on in the reverse manner.—*Machinery.*

MAGNET FOR REMOVING METAL FROM THE FLESH

A magnet for removing metal embedded in the flesh, which is one of the most powerful in the world, has been installed by the Westinghouse Electric & Manufacturing Company in the relief department of its East Pittsburgh works. The magnet is mounted on a box containing the resister, which is used to regulate the amount of current flowing through the coils. It requires 4,000 watts for its operation, or enough power to supply 100 Mazda lamps of 32 candle power each, and is designed for operation on 70 volts.

It is not an infrequent occurrence for steel and iron workers to get bits of metal in their eyes or hands. Previous to the installation of a magnet the only means of removal was

Magnet in Operation, Removing Steel from the Eye

by probing, a method which is as uncertain as it is painful. Since this machine was put in operation it is a very simple proceeding to extract such particles. The portion of the body in which the foreign particle is embedded is placed near the pole tip of the magnet, the switch is closed, and the magnet does the rest. Some remarkably small pieces have been extracted in this way. The pole piece is removable, a number of different shapes being supplied for various classes of work.

MACHINE POWER AND PIECEWORK.—In any shop if the feeds, speeds and power of machine tools of the same class vary, it is a practical impossibility to establish a just and efficient piecework or premium system.—*American Machinist.*

MATERIALS FOR CASEHARDENING.—The composition of casehardening materials varies very widely. The following table shows the range of variation in seventeen commercial compositions tested:

	Per Cent
Moisture	2.68 to 26.17
Oil	0.17 to 20.76
Carbon (organic)	6.7 to 54.19
Calcium phosphate	0.32 to 74.75
Calcium carbonate	1.2 to 11.57
Barium carbonate	nil to 42.0
Zinc oxide	nil to 14.5
Silica	nil to 8.14
Sulphates (SO_3)	trace to 3.45
Sodium chloride	nil to 7.88
Sodium carbonate	nil to 40.0
Sulphides (S)	nil to 2.8

—*Machinery.*

NEWS DEPARTMENT

E. B. Roberts, smoke inspector of the city of Cleveland, has submitted a report showing that the density of locomotive smoke during the second half of 1914 decreased 79 per cent, as compared with the second half of 1912.

A press despatch from Vera Cruz, Mexico, February 2, announced the re-opening of the railroad between that place and Mexico City, with a passenger train running through for the first time since November 19.

The Chicago & Alton has reached an agreement with a committee representing its trainmen, providing for increases in pay for flagmen and train baggagemen, and a number of changes in working conditions, including payment for terminal overtime, and extra payments for work outside of the regular routine.

Representatives of the conductors', trainmen's, enginemen's and firemen's unions, in Ohio, have announced that they will concentrate their efforts before the legislature this year on the effort to secure the passage of the train limit bill and to oppose the repeal of the extra crew law, but will urge no other anti-railroad legislation.

A bill has been introduced in the Missouri legislature to require interstate railroads to establish stations not more than five miles from the state line, to put an agent in charge and to stop trains long enough to enable passengers to buy new tickets and have their baggage rechecked, in order to take advantage of the lower intrastate passenger fares.

The Secretary of the Interior has recommended to Congress an appropriation of $2,000,000 for the use of his department in the work of building the proposed government railroad in Alaska. An appropriation of $1,000,000 was made at the last session of Congress. The secretary has not yet reached any decision as to the purchase of the Copper River & North Western or the Alaska Northern, both of which roads may be included in the proposed government system.

H. W. Thornton, formerly general superintendent of the Long Island Railroad, now general manager of the Great Eastern of England, has "made good." This statement came in a recent press despatch from London, saying that at the annual meeting of the shareholders of the Great Eastern, Lord Claud Hamilton, the chairman of the company, paid Mr. Thornton a special tribute; and that the meeting unanimously agreed that Mr. Thornton, already, before filling out a year's service, had fairly justified his selection as manager.

Five years ago, in co-operation with the Pennsylvania State College, the Pennsylvania Railroad organized its first class of apprentices for school instruction. The school was established at the Altoona shops and 30 pupils were enrolled. Three branch schools have since been opened at other points on the line, and today the total enrollment numbers 300 young men. Thus far, 151 apprentices have completed the full three-year course and have been graduated from the school; approximately 60 more will be added to this number by the classes going out this year.

The American Museum of Safety, William H. Tolman, director, made its annual award of medals on February 10, at the United Engineering Societies building, 29 West Thirty-ninth street, New York City. The E. H. Harriman Memorial medal for the American steam railroad, which during one year has been the most successful in protecting the lives and health of its employees and of the public, was presented to the New York Central. The Anthony N. Brady medal for a similar purpose, awarded to an electric railway, went to the Boston Elevated.

The railroad committees of the house and senate of the Kansas legislature held a hearing on February 1, on the extra crew, the train limit and other bills affecting railroads and their employees. Officers of the railroads and representatives of the employees appeared and presented arguments. All of the employees' representatives favored the bills, except a negro porter, representing the porters, who opposed the extra crew bill, on the ground that if an extra brakeman or flagman were required on passenger trains the elimination of the train porters would follow. A. De Bernardi, general superintendent of the Missouri Pacific, said that if the bill were passed, for every extra brakeman added it would be necessary for many roads to lay off two trackmen as a measure of economy, and that the trackmen were more essential to safety than the extra brakeman. Representatives of the roads also brought out the fact that the trainmen had never attempted to negotiate with the officers of the roads for extra brakemen.

A TALK TO APPRENTICES

On February 15, George M. Basford, chief engineer of the railroad department of Joseph T. Ryerson & Son, made an address before the apprentices of the Chicago & North Western at Chicago. The talk was intended to give the boys a bigger and broader view of the opportunities which lay before them and of the possibilities which might result if they were to follow their work in the right spirit. The title of the address was "Making Heroes." "Choose to be heroes," said Mr. Basford, "in the heroism of simple honesty in the work which shows and in that which lies concealed, that you may look back in years that are to come, proud that you have done an important part in making the Chicago & North Western a better railroad. To see what is right and not to do it, is want of courage." The address was enthusiastically received.

A. S. M. E. BOILER CODE

The boiler code committee of the American Society of Mechanical Engineers has made a final report on this subject, which has been accepted by the council. This final report is the result

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Mar. 9	Railway Advertising	Edward Hungerford..	James Powell....	St. Lambert, Que.
Central	Mar. 11	Rules of Interchange	Committee Report....	Harry D. Vought.	95 Liberty St., New York.
New England....	Mar. 9	Annual Meeting	.....	Wm. Cade, Jr....	683 Atlantic Ave., Boston, Mass.
New York.....	Mar. 19	Annual Electrical Night	.....	Harry D. Vought.	95 Liberty St., New York.
Pittsburgh	Mar. 26	Rules of Interchange.....	Committee Report....	J. B. Anderson...	207 Penn Station, Pittsburgh, Pa.
Richmond	Mar. 8	Railways and Agricultural Development....	F. H. La Baume....	F. O. Robinson...	C. & O. Ry., Richmond, Va.
St. Louis.....	Mar. 12	Methods of Wage Payments.....	F. H. Hamilton.....	B. W. Frauenthal.	Union Station, St. Louis, Mo.
South'n & S'w'rn.	Mar. 18	Relations Between Mechanical, Purchasing and Stores Departments	R. E. Smith, C. Pierce and W. D. Stokes..	A. J. Merrill.....	Box 1205, Atlanta, Ga.
Western	Mar. 16	.....	Frank McManamy...	Jos. W. Taylor...	1112 Karpen Bldg., Chicago, Ill.
Western Canada..	Mar. 8	Fuel Oil in Extreme Climates.....	J. G. LeGrand.....	Louis Kon	Box 1707, Winnipeg, Man.

of the work of the original committee, of which John A. Stevens is chairman, and an advisory committee consisting of engineers representing various phases of the design, installation and operation of boilers. This advisory committee included the following representatives from the railway field: F. H. Clark, general superintendent of motive power of the Baltimore & Ohio; A. L. Humphrey, vice-president and general manager of the Westinghouse Air Brake Company; H. H. Vaughan, assistant to vice-president, Canadian Pacific Railway, and W. F. Kiesel, Jr., assistant mechanical engineer of the Pennsylvania Railroad. The code is considerably shorter than when originally brought out by the committee; and the rules laid down in it, of course, do not apply to boilers which are subject to federal inspection and control. The original committee and the advisory committee have been continued as one and will meet once a year in order to make any changes that advances in practice may make necessary. At these meetings will also be taken up any change which may seem necessary in a rule because it works unnecessary hardship on any particular class of boiler makers or users.

MEETINGS AND CONVENTIONS

American Society for Testing Materials.—The eighteenth annual meeting of the American Society for Testing Materials will be held at the Hotel Traymore, Atlantic City, N. J., on June 22-26, 1915.

Air Brake Association.—The twenty-second annual convention of the Air Brake Association will be held at the Hotel Sherman, Chicago, Ill., Tuesday, May 4, 1915. Committees will report on the Accumulation of Moisture and its Elimination from Trains and Yard Testing Plants, Adequate Hand Brakes on Heavy Passenger Equipment Cars, Need of Efficient Cleaning and Repairing of Freight Brakes, What Shall We Do to Improve the Present Pneumatic Signal Device, Difficulties the Railroad Companies Encounter in Endeavoring to Run 100 Per Cent Operative Brakes in Freight Service, and M. C. B. Air Brake Hose Specifications.

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.

Air Brake Association.—F. M. Nellis, 53 State St., Boston, Mass. Convention, May 5-7, 1915, Hotel Sherman, Chicago.

American Railroad Master Tinners, Coppersmiths and Pipefitters' Association.—W. E. Jones, C. & N. W., 3814 Fulton street, Chicago. Annual meeting, Chicago.

American Railway Master Mechanics' Association.—J. W. Taylor, Karpen building, Chicago. Convention, June 9-11, 1915, Atlantic City, N. J.

American Railway Tool Foremen's Association.—Owen D. Kinsey, Illinois Central, Chicago. Convention, July 19-21, 1915, Hotel Sherman, Chicago.

American Society for Testing Materials.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Convention, June 22-26, 1915, Hotel Traymore, Atlantic City, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth street, New York. Annual meeting, December 7-10, 1915, New York.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Sta., Chicago. Annual meeting, October, 1915.

Car Foremen's Association of Chicago.—Aaron Kline, 841 North Fiftieth Court, Chicago; 2d Monday in month, except July and August, Lytton building, Chicago.

Chief Interchange Car Inspectors' and Car Foremen's Association.—S. Skidmore, 946 Richmond street, Cincinnati, Ohio.

International Railway Fuel Association.—C. G. Hall, 922 McCormick building, Chicago. Convention, May 17-20, 1915, Chicago.

International Railway General Foremen's Association.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, July 13-16, 1915, Hotel Sherman, Chicago.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, Lima, Ohio. Convention, August 17, 1915, Philadelphia, Pa.

Master Boiler Makers' Association.—Harry D. Vought, 95 Liberty street, New York. Convention, May 26-28, 1915, Chicago, Ill.

Master Car Builders' Association.—J. W. Taylor, Karpen building, Chicago. Convention, June 14-16, 1915, Atlantic City, N. J.

Master Car and Locomotive Painters' Assoc. of U. S. and Canada.—A. P. Dare, B. & M., Reading, Mass. Convention, September 14-17, 1915, Detroit, Mich.

Niagara Frontier Car Men's Association.—E. Frankenberger, 623 Brisbane building, Buffalo, N. Y. Meetings monthly.

Railroad Master Tinners, Coppersmiths and Pipefitters' Association.—U. G. Thompson, C. & E. I., Danville, Ill. Annual meeting, May, 1915.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 17-19, 1915, Hotel Sherman, Chicago.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. & H. R., East Buffalo, N. Y. Convention, September, 1915, Chicago, Ill.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

A. R. Ayers, who was general mechanical engineer of the Lake Shore & Michigan Southern and other New York Central lines west of Buffalo with office at Chicago, has been appointed principal assistant engineer of the New York Central, general duties car design and construction, with headquarters at New York.

R. M. Brown has been appointed assistant engineer, in charge of engineering and drafting at the locomotive and car shops of the New York Central, with headquarters at Cleveland, Ohio.

Joseph Chidley, assistant superintendent of motive power and rolling stock of the New York Central, with headquarters at Cleveland, Ohio, now has jurisdiction over the Illinois division.

F. S. Gallagher has been appointed assistant engineer, in charge of car design and specifications of the New York Central, with headquarters at New York.

W. B. Geiser, who was acting chemist and engineer of tests of the New York Central & Hudson River at West Albany, N. Y., has been appointed assistant chemist and engineer of tests of the New York Central at West Albany.

P. P. Mirtz, who was mechanical engineer of the Lake Shore & Michigan Southern at Cleveland, Ohio, has been appointed assistant engineer, in charge of locomotive design and specifications, of the New York Central, with headquarters at New York.

E. F. Needham, superintendent of the locomotive and car departments of the Wabash, has removed his office from Springfield, Ill., to Decatur.

P. Roquemore has been appointed mechanical engineer of the International & Great Northern, with office at Palestine, Texas.

H. E. Smith, who was chemist and engineer of tests of the Lake Shore & Michigan Southern at Collinwood, Ohio, has been appointed chemist and engineer of tests, with supervision over laboratories and material inspection, of the New York Central, with headquarters at Collinwood, Ohio.

G. Whiteley, master mechanic of the Alberta division of the Canadian Pacific, at Calgary, Alta., has been appointed assistant superintendent of motive power of the Eastern Lines, with headquarters at Montreal, Que.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

S. T. Armstrong has been appointed master mechanic of the International & Great Northern at Palestine, Tex., succeeding T. Windle, resigned.

E. J. Bryant, general foreman of the International & Great Northern at Houston, Tex., has been appointed master mechanic at Mart, Tex.

A. F. Caskey has been appointed road foreman of equipment of the Des Moines Valley division of the Rock Island Lines, and that part of the Dakota division between Valley Junction and Gowrie, with headquarters at Valley Junction, Ia.

A. E. Dales has been appointed district master mechanic of the Canadian Pacific at Brandon, Man., succeeding L. G. Fisher.

L. G. Fisher, formerly district master mechanic of the Canadian Pacific at Brandon, Man., has been appointed district

master mechanic at Cranbrook, B. C., succeeding A. Sturrock, promoted.

J. T. FLAVIN has been appointed master mechanic of the Illinois division of the New York Central at Gibson, Ind.

GEORGE S. GRAHAM has been appointed master mechanic of the Pennsylvania division of the Delaware & Hudson at Carbondale, Pa., succeeding John J. Reid, transferred.

N. M. BARKER, whose appointment as master mechanic in charge of the mechanical and supply departments of the Copper Range Railroad at Houghton, Mich., has been announced in these columns, entered railroad service as a machinist apprentice and was employed as a machinist for several years on western roads, during which time he prepared himself for college. He entered the University of Arizona at Tucson, where he specialized in mechanical engineering, and at the same time was engaged as instructor in machine shop practice. Upon leaving college he again entered railway service as machine shop foreman of the Cerro de Pasco Railway at Cerro de Pasco, Peru, and was later appointed assistant master mechanic of this road. Mr. Barker left this position to return to the United States, where he again took up railway work, being employed as a draftsman on the Nevada Northern at Ely, Nev. He left this road to become superintendent of construction for the A. Hughes Construction Company, Denver, Colo., and for the past several years has been engaged in this capacity on general engineering work in the West. He severed his connection with this company on his appointment as master mechanic of the Copper Range as above noted.

N. M. Barker

W. H. KELLER has been appointed assistant master mechanic of the Baltimore & Ohio Southwestern, at Cincinnati, Ohio, succeeding A. E. McMillan.

C. KYLE has been appointed master mechanic of the Atlantic division of the Canadian Pacific at St. John, N. B.

A. E. MCMILLAN, assistant master mechanic of the Baltimore & Ohio Southwestern, at Cincinnati, Ohio, has been appointed master mechanic of the Indiana and Illinois divisions, with headquarters at Washington, Ind.

JOHN J. REID, master mechanic of the Pennsylvania division of the Delaware & Hudson at Carbondale, Pa., has been appointed master mechanic of the Susquehanna division, with headquarters at Onconta, N. Y., succeeding William Malthaner.

H. SELFRIDGE, formerly general foreman of the Oregon Short Line at Salt Lake City, Utah, has been appointed master mechanic of the Nevada Northern at East Ely, Nev. Mr. Selfridge was born on July 12, 1872, at Brownsville, Minn., his parents soon afterward moving west and settling in Oregon. After receiving a high school education he became a machinist apprentice in Tacoma, Wash., finishing with a special course of one year in the boiler shop. He then entered the service of the Central Pacific at Sacramento, Cal., as a locomotive fireman. In 1898 he was promoted to engineman, in which capacity he was employed on various divisions of the Southern Pacific until the fall of 1905, when he left the service to engage in other business. Mr. Selfridge subsequently re-entered railway work, being employed in the locomotive service of the San Pedro, Los Angeles & Salt Lake, the Denver & Rio Grande and the Union Pacific until April, 1907. He then entered the service of the Oregon Short Line as district foreman, and has since been connected with that road in various capacities until his appointment as master mechanic of the Nevada Northern, as noted above.

A. STURROCK, district master mechanic of the Canadian Pacific at Cranbrook, B. C., has been appointed master mechanic of the Alberta division at Calgary, Alta., succeeding G. Whiteley, promoted.

E. B. VAN AKIN has been appointed road foreman of equipment of the Minnesota division of the Rock Island Lines at Manly, Iowa.

A. YOUNG, roundhouse foreman of the Chicago, Milwaukee & St. Paul, at Chicago, has been appointed district master mechanic at Milwaukee, Wis.

W. MALTHANER whose appointment as master mechanic of the Baltimore & Ohio at Newark, Ohio, was announced in these columns last month, was born at Salem, N. Y., August 4, 1874. He entered railroad service as a machinist apprentice on the Delaware & Hudson at Green Island, N. Y., in 1889, and at the end of four years was made a gang foreman in the same shop, serving in this capacity on various classes of work until 1896. He then left railway work and served as a machinist for the General Electric Company and other manufacturing companies for two years, when he again entered the Green Island shops of the Delaware & Hudson as foreman of the air brake department. In 1900 he became terminal foreman of the same road at Schenectady, N. Y., and after two years in this capacity was appointed general foreman at Plattsburgh, N. Y. In 1904 he was made division master mechanic of the Saratoga & Champlain divisions of the Delaware & Hudson, which position he occupied until 1912, when he was transferred to the Susquehanna division. He leaves this position to enter the service of the Baltimore & Ohio.

W. Malthaner

CAR DEPARTMENT

A. BERG has been appointed general foreman, car department of the New York Central at Wesleyville, Pa., succeeding O. Blodd, transferred.

O. BLODD, formerly general foreman of the car department of the New York Central at Wesleyville, Pa., has been transferred to Sandusky, Ohio, as general car foreman at that point, succeeding R. A. Fitz, transferred.

R. A. FITZ, formerly general car foreman of the New York Central at Sandusky, Ohio, has been transferred to Nottingham, Ohio, as general car foreman.

W. B. MCNIECE, formerly car foreman of the Grand Trunk Pacific at Jasper, B. C., has been appointed car foreman at McBride, B. C.

T. Spence, formerly car foreman of the Canadian Pacific at Fort William, Ont., has been appointed general car foreman at Vancouver, B. C., succeeding W. C. Hodgson.

George Thompson, district master car builder of the New York Central at Englewood, Ill., has had his jurisdiction extended over the Illinois division.

SHOP AND ENGINE HOUSE

E. Bloom has been appointed shop demonstrator and chief apprentice instructor, of the Chicago & North Western at Chicago, Ill., succeeding E. H. Morey.

George H. Laycock has been appointed locomotive foreman of the Grand Trunk Pacific at Endako, B. C., succeeding George McNeil.

C. Lundburg has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul at Chicago, succeeding A. Young.

John McRae, locomotive foreman of the Canadian Pacific at Revelstoke, B. C., has been appointed shop foreman at Kamloops, B. C., succeeding G. Dillard.

E. H. Morey, shop demonstrator and chief apprentice instructor, has been appointed foreman of the new erecting and machine shop of the Chicago & North Western, at Chicago, Ill.

J. A. Mitchell has been appointed locomotive foreman of the Grand Trunk Pacific at Biggar, Sask., succeeding A. S. Wright.

C. M. Newman has been appointed superintendent of shops of the Baltimore & Ohio Southwestern at Washington, Ind.

COMMISSION APPOINTMENTS

Walter Alexander, who has just been appointed a member of the Railroad Commission of Wisconsin, has for the past 13 years held positions as assistant district master mechanic and district master mechanic at Minneapolis and Milwaukee of the Chicago, Milwaukee & St. Paul. The law creating the Railroad Commission requires that one member be familiar with transportation conditions and problems, and it was Governor Philipp's idea that a man who has had practical experience in railroad operation, as well as a technical training as a mechanical engineer, would be best suited for the position. Mr. Alexander was born in Glasgow, Scotland, and went to Milwaukee in 1873. After receiving a common school education he served an apprenticeship as a machinist and draftsman with the Chicago, Milwaukee & St. Paul, and was also employed as a fireman on that road. While so employed he prepared himself for college and entered the University of Wisconsin in 1893, graduating in the mechanical engineering course in 1897; and he received a second degree in engineering the following year. After three years' instructional work in engineering at the University of Wisconsin, one year at Armour Institute and one at the University of Missouri he returned to railroad service as assistant district master mechanic of the St. Paul at Minneapolis. Two years later he was transferred to Milwaukee to a similar position, and later was made district master mechanic, which position he has held up to the present.

Walter Alexander

Supply Trade Notes

Jed O. Gould, general superintendent and works manager of the Gould Coupler Company, at Depew, N. Y., died Friday, February 19, at Buffalo, N. Y.

The Zug Iron & Steel Company, Pittsburgh, Pa., has been acquired by Jos. T. Ryerson & Son, Chicago. The plant is to be dismantled and a warehouse will be erected on the site.

George T. Merwin, formerly with the W. W. Butler Company, Ltd., Montreal, Que., has been appointed general sales manager of the Canadian Car & Foundry Company, Montreal, Que.

The Fairmont Machine Company, Fairmont, Minn., has changed its name to the Fairmont Gas Engine & Railway Motor Car Company, and has increased its authorized capital stock to $1,000,000.

George Gibson Barret, formerly general manager of the Cleveland Drop Forge Company, and at one time connected with the American Locomotive Company, died at his home in Commack, L. I., on February 16.

James S. Llewellyn has been elected secretary, and Paul Llewellyn treasurer of the Chicago Malleable Castings Company. James S. Llewellyn will continue to hold the office of works manager at the West Pullman works.

John H. Trent, formerly railroad representative of the H. W. Johns-Manville Company, New York, at St. Louis, Mo., has been transferred to New Orleans, La., as branch manager, and has been succeeded at St. Louis by W. B. Mallette.

C. B. McElhany, assistant general manager of sales of the Cambria Steel Company, has been appointed general manager of sales, succeeding J. Leonard Replogle, who has resigned to enter the service of the American Vanadium Company.

William H. Kinney, formerly master mechanic of the New York, Ontario & Western at Carbondale, Pa., has entered the railroad sales department of the Dearborn Chemical Company, Chicago, and will have headquarters at the company's New York office.

C. H. Rhoader, who has been connected with the St. Louis Surfacer & Paint Company, St. Louis, Mo., for four years, and with the Valentine Varnish Company for two years, was recently appointed western railway representative of the Kay & Ess Company, Dayton, Ohio.

C. F. Quincy, president of the Q & C Company, New York, has acquired the entire capital stock of the Railway Appliances Company, Chicago, formerly owned by Percival Manchester. The business of the Railway Appliances Company will hereafter be operated by, and in the name of the Q & C Company.

W. S. Ottinger, district sales manager of the Cambria Steel Company, has been appointed assistant general manager of sales, effective March 1, to succeed C. B. McElhany, promoted. Mr. Ottinger will be succeeded as district sales manager by F. J. Krouse. Albert S. Johnson will become assistant district sales manager, succeeding Mr. Krouse.

Due to the existence of a battery jar marketed under the name "Titan," and the fact that any battery using these jars might appear as a Titan battery, the Titan Storage Battery Company, Newark, N. J., has changed its name to the General Lead Batteries Company. No change whatever in ownership, officers or policy is involved. The change is made merely to avoid confusion.

Charles E. Poyer has been appointed assistant general sales manager of the Edison Storage Battery Company, Orange, N. J. Mr. Poyer has been with the Edison interests for about four years, having served first on the personal engineering

staff of Mr. Edison in the development of special applications of the alkaline battery, and later as assistant advertising manager. For the past two years he has been manager of the house lighting department.

James F. McElroy, president of the Consolidated Car Heating Company, Albany, N. Y., died at Laconia, N. H., on February 10. Mr. McElroy was prominent as an inventor and business man, and was identified with several of Albany's banking and mercantile institutions. He was born in Greenfield, Ohio, November 25, 1852, and was graduated from Dartmouth College in 1876. For four years following Mr. McElroy was the principal teacher of the Indianapolis Institution for the Blind, and then for seven years was superintendent of the Michigan Institution for the Blind. In 1887 he organized the McElroy Car Heating Company, operating its own patents. Two years later it was combined with the Sewall Car Heating Company.

J. Leonard Replogle, vice-president and general manager of sales of the Cambria Steel Company, since September, 1912, has resigned, effective March 1, to accept the position of vice-president and general manager of sales of the American Vanadium Company. Mr. Replogle has been in the service of the Cambria Steel Company for approximately 26 years. He was born in Bedford county, Pa., on May 6, 1876, and was educated in the public schools of Johnstown. He entered the employ of the Cambria Steel Company as an office boy when he was but 13 years of age and served successively as clerk, shipper, assistant superintendent of the axle department, superintendent of the forge, axle and bolt departments, assistant to the assistant general manager, superintendent of the order department, assistant general manager, assistant to president and vice-president and general manager of sales. Mr. Replogle will have offices at New York and Pittsburgh.

J. L. Replogle

H. Ward Leonard, president of the Ward Leonard Electric Company, Bronxville, N. Y., died suddenly of apoplexy, as he was about to attend a banquet of the American Institute of Electrical Engineers at the Hotel Astor, New York, on Thursday, February 18. Mr. Leonard was a prominent electrical engineer and inventor. He was born in Cincinnati on February 8, 1861. He graduated from the Massachusetts Institute of Technology, and when he was 23 years of age became associated with Thomas A. Edison as a member of Mr. Edison's staff of four engineers selected to introduce the Edison Central Station System. When he was 26 years of age he became general superintendent of the Western Electric Light Company at Chicago. The following year he formed the firm of Leonard & Izard, which made many important installations of central stations and electric railways. In 1889, when the firm was bought out by the Edison interests, Mr. Leonard became general manager of the combined Edison interests for the United States and Canada, with headquarters in New York. In 1891 he completed his inventions of the Ward Leonard system of motor control, and later introduced several other important inventions in the electrical field.

J. A. McFarland has been appointed southwestern district manager of the Bird-Archer Company, Chicago, with headquarters in the Frisco building, St. Louis, Mo. Mr. McFarland was born on October 23, 1880, at Mendota, Ill. After finishing his common school education he entered the University of Illinois, from which he graduated in 1903, having specialized in chemistry. He began railway work in May of the same year in the chemical department of the Atchison, Topeka & Santa Fe, at Topeka, Kan. On January 1, 1904, he became assistant in the testing department of the Chicago & North Western. In February, 1905, he became chief chemist of the Missouri Pacific, in which position he remained until May, 1909, when he took charge of the St. Louis office of the Dearborn Chemical Company, Chicago, looking after the latter's railroad business in that territory. In July, 1911, he left that company to become chemist and engineer of tests of the Frisco System, and was later connected with the Standard Railway Equipment Company, New Kensington, Pa., until his recent appointment with the Bird-Archer Company, as noted above.

J. A. McFarland

Lyndon F. Wilson, vice-president of the Railway List Company, Chicago, has resigned to become vice-president of the Bird-Archer Company, Chicago, effective April 1, 1915. Mr. Wilson was born at Rush Lake, Wis., November 4, 1883. He was educated at Ripon College, Lawrence University, and the University of Wisconsin. Before entering college, however, he was an operator in the office of his father on the Chicago, Milwaukee & St. Paul. Later, after having had considerable machine shop and power plant experience, he became an engineer in the Department of the Interior of the United States government, after having passed examinations in steam, electricity and heating and ventilating. After one year in this service, he joined the engineering department of the Western Electric Company, and remained with the latter until the fall of 1908, when he became mechanical department editor of the Railway Review. In the spring of 1909 he became editor of the Railway Master Mechanic, and was subsequently given editorial charge of Railway Engineering, both being published by The Railway List Company, Chicago. He was promoted to the vice-presidency of this company in the summer of 1913. After April 1, Mr. Wilson will be located in the Chicago office of the Bird-Archer Company.

L. F. Wilson

CATALOGS

TUMBLERS.—The Whiting Foundry Equipment Co., Harvey, Ill., has issued catalog No. 113 which is entirely given over to descriptions of the line of tumblers manufactured by this company for use in various classes of foundry work. The catalog, which is well illustrated, will be sent free upon request.

BRASS FOUNDRY EQUIPMENT.—Catalog No. 114 of the Whiting Foundry Equipment Co., Harvey, Ill., deals with the line of brass foundry equipment developed by this company. The line includes cranes, furnaces and tumblers as well as a line of tongs and shanks for handling crucibles. The catalog will be sent free upon request.

PAINT.—The first number of a publication to be known as The Scientist has been received from the Goheen Manufacturing Company, Canton, Ohio. It is intended to devote the space in this booklet to the advancement of the iron, steel and galvanized iron preservatives, as well as the water-proofing compound and damp-proofing paint of which the Goheen Manufacturing Company is the maker.

VALVES.—A 40-page catalog recently issued by the Homestead Valve Manufacturing Company, Homestead, Pa., deals with the different types of valves which this company manufactures. Illustrations and the principal dimensions of the different types are given and a cross-section showing the construction of the Homestead straightway valve is included on page 7, with detailed descriptive matter.

VENTILATION.—A pamphlet has been issued by the American Blower Company, Detroit, Mich., entitled Ventilating the Fletcher Savings and Trust Company Building. It contains a brief description of the Sirocco ventilating system as applied to an office building in Indianapolis, Ind. A number of drawings are included showing the layout of the system and a number of types of Sirocco multiblade fans are illustrated.

PAINTS.—The ninth edition of the Review of Technical Paints, by Frank P. Cheesman, has just been issued by Cheesman & Elliott, 100 William street, New York. This book contains 52 pages, is illustrated and is intended to give anyone interested in metal painting the benefit of the long experience of this firm. Various kinds of paints are considered in detail and information given as to the best paint to use for any particular class of work.

VALVE GEARS.—A booklet recently received from the Southern Locomotive Valve Gear Company, Knoxville, Tenn., contains some interesting data regarding the Southern valve gear. A number of indicator cards are included from locomotives fitted with this type of gear as well as data taken from the results of tests of locomotives to which this gear has been applied. Illustrations of the gear itself as well as locomotives fitted with it are included.

TAPS AND DIES.—The Wiley & Russell Manufacturing Company, Greenfield, Mass., has recently issued catalog No. 36, which deals with the screw cutting tools and machinery manufactured by this company. It is a book of pocket size containing 285 pages and besides illustrations and detailed information concerning the taps, dies, gages, etc., it contains, near the end, a number of tables of decimal equivalents, standards for wire gage, metric screw threads, etc.

SMALL TURBO-GENERATOR SETS.—The General Electric Company, Schenectady, N. Y., has issued an attractive bulletin, No. 42,010, describing in considerable detail the horizontal turbo-generator sets of small capacities. These machines are built in capacities ranging from 7 kw. to 300 kw. direct current, and 100, 200 and 300 kw. alternating current, and are used largely for supplying light and power in mills, machine shops, laundries, etc., as well as for train lighting.

SNOW FLANGERS.—A 16 page booklet has recently been received from the Railway Appliance Company, Old Colony building, Chicago, describing the improved type of Ray self-contained snow flanger. This device, which is applied directly to the locomotive, is designed to keep the rail and flangeway clear of light snowfalls. It is also used on wedge plows for clearing the flangeway. The booklet is well illustrated and contains a number of interesting photographs of snow-fighting scenes.

WATER SOFTENERS.—The Harrison Safety Boiler Works, Philadelphia, Pa., has recently issued a 20-page leaflet devoted to the Sorge-Cochrane Hot Process Water Softening System. The process, which is based upon the fact that chemical reactions are more rapid and complete in hot water than in cold water, is described in the leaflet which also contains a brief treatise on the chemistry of water softening. The text is well supplemented by a number of diagrammatic views showing the operation of the softener.

CENTRIFUGAL PUMPS.—This is the title of a 64-page bulletin, No. 19, just issued by the Terry Steam Turbine Company, Hartford, Conn., giving details and data on various turbo-pump applications. The principles of operation and construction of the centrifugal pump are explained, as are details of the steam turbine. Because of the wide latitude of speed possible with the turbine, the unit occupies a much smaller space than would be required for a pump performing the same duty but driven by a reciprocating engine.

MULTIPORT VALVES.—Cochrane Multiport Valves is the subject of a booklet of 72 pages just issued by the Harrison Safety Boiler Works, Philadelphia, which describes the multiport valves introduced by that company for back pressure relief and vacuum service, flow service in connection with mixed flow turbines, and check valve service with bleeder or extraction turbines. The essential idea of the multiport valve is the use of a number of small discs instead of one large disc, in order to secure greater safety, quietness, lightness of moving parts and tightness.

ENGINEERING CALCULATIONS.—This is the title of a 23 page booklet issued by Felt & Tarrant Manufacturing Company, Chicago, which deals with the application of the comptometer to calculating work in the drafting room and the estimating department for a variety of calculations involving addition, multiplication, division and subtraction. It is well illustrated and contains numerous examples of the operations for which the machine is being used. The booklet will be of interest to those in charge of engineering offices and drafting rooms generally.

RAILWAY LINE MATERIAL.—The General Electric Company has recently issued bulletin No. 44,004, which forms an ordering catalog devoted to railway line material for direct suspension. This publication covers practically everything in line material for this method of suspension, except poles and wire. The parts are illustrated and each illustration is accompanied by the proper catalog numbers. The prices are not included. The bulletin contains also miscellaneous data relative to construction, overhead material per mile, general data on the use of solid copper wire and copper cable, dimensions of grooved trolley wire sections, etc.

PUMPS.—The National Transit Company, Department of Machinery, Oil City, Pa., has just issued bulletins Nos. 1, 2, 4, 101 and 301, all of which are contained in a neat binder and are devoted to its line of pumping machinery for general service recently added to the line of oil and gas pumping machinery which it has previously manufactured. In bulletin No. 1 are illustrated the pumps for different classes of service manufactured by this company including the duplex, crank and fly-wheel direct steam driven and geared pumps; a line of gas engines and a line of pipe fittings. The other bulletins are each devoted to a particular class of service.